A. R. HOWLAND

Multi-band
SWEEP OSCILLATOR

Model 9510 Push Button Control Unit

Model 9511 Plug-in Container Unit

9510 Serial _____ 9511 Serial _____ 9511 Serial _____ 9511 Serial _____ 9511 Serial _____ 9511 Serial _____

File: S69

2678

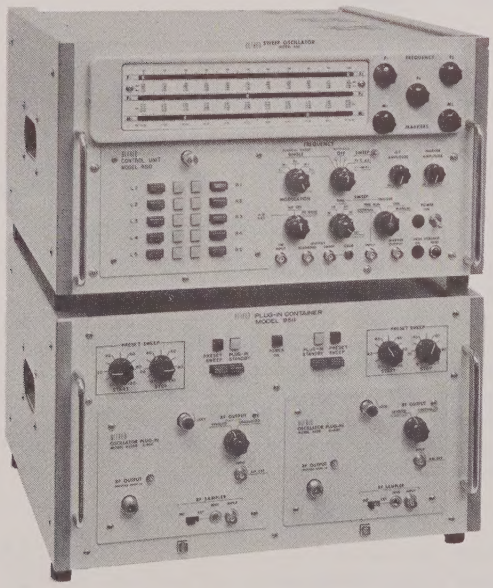
ALFRED ELECTRONICS 3176 PORTER DRIVE, PALO ALTO, CALIF.

INSTRUCTION MANUAL

Multi-band
SWEEP OSCILLATOR

Model 9510 Push Button Control Unit
Model 9511 Plug-in Container Unit

9510 Serial 9511 Serial 9511 Serial 9511 Serial 9511 Serial 9511 Serial



A. R. HOWLAND

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TELEPHONE: 326-6496 • TWX: 910-373-1765

~~Manual 650-1~~

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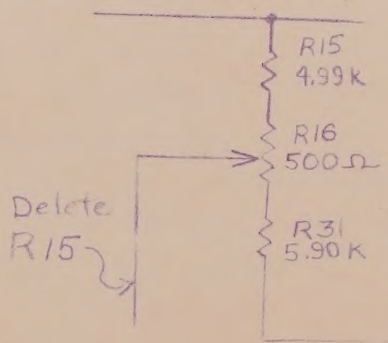
Date	ECO#	Effective Serial's	Revision
3-10-69 3-21-69	14062	All S/N 11 & up	In Section 7, Schematic D907318, change R58 from 4.7K to 1K. In the Parts List, Section 6, page 6-2 make the following change: C1 13-78 Capacitor, fixed, elect., 4000 mf, 15 v. Also in the Parts List, page 6-3, make the following changes: Delete A3C1 A3C2 13-69 Capacitor, fixed, elect., 100 mf, 15 v Delete A3C7 Add: A3C8 13-68 Capacitor, fixed, elect., 3.3 mf, 15 v A3C9 12-2 Capacitor, fixed, ceramic, .001 mf, 600 v A3C10 and A3C11 Same as A3C3 A3R13 51-3.3K Resistor, fixed, dep. carb., 3.3K, 1/2 w, 5% A3R18 51-18K Resistor, fixed, dep. carb., 18K, 1/2 w, 5% A3R25 51-2.7K Resistor, fixed, dep. carb., 2.7K, 1/2w, 5% A3R55 Same as A3R14 Add: A3VR5 81-175 Diode, Zener, MZ-1000-24
6-20-69	14137	28 & up	In the Parts List, page 6-4, change A4R15, A4R16, and A4R31 as follows: A4R15 56-4.99K Resistor, fixed, MF, 4.99K, 1/2 w, 1% A4R16 77-148 Resistor, variable, 500 Ω A4R31 56-5.90K Resistor, fixed, M.F., 5.90K, 1/2 w, 1% In Section 7, Schematic 907317, make changes as shown below: 

Date	ECO#	Effective Serial's	Revision
7-9-69		All	In the Parts List, page 6-4, add the following insert after A4A1Q1 & A4A1RT1: normally replaceable only as an assembly (A4A1), Alfred Part No. 951729.
7-10-69	ECR 363	S/N 11 & up	On the Model 9511 Power Supply P.C. Board A1, Assy 951694, the silkscreened Ref. designators for A1Q4 & A1Q5 are reversed. A1Q4 should be the most forward transistor.

INSTRUCTIONS FOR RETRO-FITTING THE ALFRED MODEL 650 SWEEP-OSCILLATOR FOR COMPATIBILITY WITH THE MODEL 9510/9511 CONTROL SYSTEM

Retro-Fit Kit, Alfred Part No. 951717, must be installed in all Model 650 Sweep-Oscillator Main Frames prior to Serial No. 1680 if the Main Frame is to be used with the Model 9510/9511 Sweep Oscillator System. This kit consists of a new rear panel and rear panel cover-plate (which have larger openings for access to the multi-pin connectors on the rear of the Model 9510 and a pre-set sweep input connector), a pre-set sweep relay assembly, miscellaneous small components necessary to update the low-voltage supply and cathode supply printed circuit assemblies and a new transfer oscillator assembly (if required). Installation of this kit does not disturb any of the internal calibration adjustments in the Model 650 nor does it change any operating parameters.

Before starting the modification procedure remove any RF plug-in unit that may be installed in the instrument, remove the left and right side handle assemblies and remove the top and bottom cover-plates being careful to retain all attaching screws.

SECTION 1: INSTALLING NEW REAR PANEL AND REAR PANEL COVER-PLATE

Step 1 - Remove the rear panel cover-plate by removing the six No. 6X32 screws securing it to the rear of the instrument. Discard the plate, but retain the six mounting screws.

Step 2 - Remove the rear panel by removing all the attaching screws securing it to the instrument body. Transfer the line cord, terminal strip and fuse-holder assembly from the old panel to the new one. Insure that these components on the new panel are wired the same as on the old one. Transfer the machined spacer block from the lower inside lip of the old panel to its identical position on the new one. Discard the old panel.

Step 3 - Strip the outer insulation and foil shielding from one end of the 4-conductor shielded cable to expose approximately 1.5 inches of conductor. Cut the white lead off flush with the foil, leaving only the red, black, green and shield leads exposed. Connect the red lead to

Pin A of the 4-Pin female Winchester connector (pre-set sweep input), the black lead to Pin B, the shield to Pin C, and the green lead to Pin D. Use small pieces of shrink tubing to cover the exposed soldered connections. Install this connector with its locking ring in the hole provided in the upper left corner of the new rear panel with Pin A up. Do not over-tighten the retaining nut as it is very easy to damage this connector.

Step 4 - Install the new rear panel on the instrument body, using the original hardware. Use caution to insure that no wires are pinched between the new panel and the instrument body during installation. Install the new rear panel cover-plate, using the original hardware.

Step 5 - Route the 4-conductor shielded cable toward the front of the instrument directly under the top lip of the right side panel.

SECTION 2: INSTALLATION OF THE PRE-SET SWEEP RELAY ASSEMBLY

Step 1 - Remove the old tie-point plate (for the "telephone coil" cord) secured to the inside of the right-hand side panel of the instrument with two No. 6X32 screws. Carefully unsolder all wires connecting to this plate and discard it, retaining the two mounting screws for subsequent use.

Step 2 - Assemble the relay, terminal lug, and cable clamps to the new tie-point bracket as shown in Figure 1.

Step 3 - Secure the two cables (coiled cord and blue-sleeved three conductor) that were removed from the old tie-point plate to the new relay assembly, using the larger of the two plastic cable clamps. Connect the leads as shown in Figure 2.

Step 4 - Connect the 1N4385 diode, CR30, as shown in Figure 2. Note that the anode end of the diode and terminal 4 (one side of the relay coil) on the relay are both tied to chassis ground.

Step 5 - Slip the 16-inch length of gray sleeving over the white/orange and orange No. 24 wires and secure this to the new relay assembly using the smaller plastic cable clamp. Connect these wires to the relay as shown in Figure 2.

Step 6 - Strip the plastic sleeving and foil shielding from the 4-conductor shielded wire (coming from the pre-set sweep input connector on the rear panel) to expose approximately 2 inches of conductor. Cut the white and shield conductors flush with the foil leaving only the red, black and green leads exposed. Connect these leads to the relay as shown in Figure 2.

Step 7 - Attach the new relay assembly to the side of the instrument, using the original hardware.

Step 8 - Mount the single lug terminal strip under the upper screw that secures the printed circuit board containing the five blue dial-calibration adjustment potentiometers to the front panel. Remove this screw carefully so that the spacer behind it does not loosen and become misaligned.

Step 9 - Unsolder the orange wire connected to the slider (S) of Helipot R41 on the front panel, and connect this wire to the single-lug terminal strip. Connect the white/orange wire coming from the relay assembly to the slider terminal (S) on the Helipot R41. Connect the orange wire coming from the relay assembly to the single-lug terminal strip. See Figure 3 for details.

SECTION 3 - MODIFICATION TO LOW VOLTAGE POWER SUPPLY PRINTED CIRCUIT ASSEMBLY "A2"

Step 1 - Remove the low-voltage supply printed circuit assembly from the instrument using care not to disturb the two adjustments on the board.

Step 2 - Remove the six .1 MF. 100 volt disc ceramic capacitors (C1, C2, C3, C4, C5, C9) from the board. Replace these capacitors with the .1 MF Mylar capacitors supplied with this kit.

Step 3 - Re-install this assembly in the basic instrument again using care not to disturb the two adjustments.

SECTION 4 - MODIFICATION OF THE CATHODE SUPPLY PRINTED CIRCUIT ASSEMBLY "A1"

During the course of manufacturing the Model 650 Sweep Oscillator there have been five major revisions to the cathode supply printed circuit board assembly. Because of this, some or all of the following modifications may already be incorporated on your board. Check the board carefully before proceeding with each of the following steps to insure that the modifications have not already been incorporated on your board. In some cases, a duplication of the components may cause improper operation. Figure 4 shows the relative position of all added components on the plated side of the board. However, if these components were installed at the factory, they will be located on the component side of the board, not necessarily in the position shown in Figure 4.

Step 1 - Remove disc capacitor C14, 100 PF. This capacitor is permanently deleted and nothing put in its place.

Step 2 - Change transistors Q2, Q3, Q4 and Q5 from type 2N3646 or type 2N706 to type 2N3643.

Step 3 - Add two 1N914 diodes from the ungrounded base of transistor Q1 to ground ⏚ (Pin N), one diode with its cathode tied to ground, and the other with its anode tied to ground.

Step 4 - Add a 1N914 diode connected between the emitter and collecter of transistor Q7, diode cathode tied to the collector.

Step 5 - Add a 1N270 diode from the collector of Q12 to ground ⏚ (Pin N), diode cathode connected to the collector.

Step 6 - Add a 1N5247B zener diode across resistor R6, diode cathode connected to the ungrounded base of Q1.

Step 7 - Add a .002 MF. disc ceramic capacitor between the base of transistor Q4 and the base of transistor Q8.

Step 8 - Add a 680K, 10%, 1/2-watt resistor from Pin U to Pin N (from the open base of Q11 to ground).

Step 9 - Add a 6.8M, 10%, 1/2-watt resistor from Pin U to Pin J (from the open base of Q11 to the +15 volt line).

Step 10 - Re-install this assembly in the basic instrument, again taking care not to disturb the two calibration adjustments on the board.

Step 11 - Remove the four 4.7M, 10%, 1/2-watt resistors (R84, R85, R86, R87) connected to terminals R and U on the cathode supply board socket, A1J5. These resistors are permanently deleted and no components installed in their place.

SECTION 5 - REPLACEMENT OF TRANSFER OSCILLATOR ASSEMBLY

Some early Model 650 Sweep Oscillaotrs have a transfer oscillator assembly that will not perform properly with the increased loading imposed by the Model 9510/9511 System. If the 650 being modified uses one of these early assemblies, it must be replaced with the current type. The older style assemblies are easily recognized by noting the type of output transistor, Q4, used. Older type transfer oscillators used a type 2N708 transistor with a finned heat sink attached while the newer assemblies use a type 2N3643 transistor without a heat sink. If transfer oscillator replacement is necessary, proceed with the following steps.

Step 1 - Remove the orange wire tied to feedthrough capacitor C17, the white/yellow wire tied to feedthrough capacitor C18, the yellow wire tied to feedthrough capacitor C19 and the black wire tied to the ground lug on the rear of the transfer oscillator box.

Step 2 - Remove the transfer oscillator cover-plate, retaining it for subsequent use.

Step 3 - Remove the green wire from terminal 6 and the white/blue/orange wire from terminal 5 of the transfer oscillator printed circuit board.

Step 4 - Remove the four flat-head screws securing the transfer oscillator box to the 650 side panel. Remove and discard the entire transfer oscillator assembly.

Step 5 - Install the new transfer oscillator box on the side panel using the original hardware taking care that the test point and adjustment access holes are up.

Step 6 - Connect the black wire to the ground lug on the back of the new transfer oscillator box, the yellow wire to the bottom feedthrough capacitor (C19), the white/yellow wire to the center feedthrough capacitor (C18) and the orange wire to the top feedthrough capacitor (C17).

Step 7 - Feed the green wire through the grommet on the end of the transfer oscillator box and connect it to terminal 6 on the transfer oscillator printed circuit board. Feed the white/blue/orange wire through a grommet on the rear of the transfer oscillator box and connect it to terminal 5 on the printed circuit board. Feed one end of the white/black/orange wire supplied with the kit through a grommet on the back of the transfer oscillator box and connect it to terminal 7 on the printed circuit board. Connect the other end of this white/black/orange wire to the Ø line test point (TP-10) located just to the rear of the transfer oscillator assembly on the side panel of the instrument.

Step 8 - Install the original transfer oscillator cover-plate using the original hardware.

On some very old Model 650 Sweep Oscillators it may be impossible to mechanically fit the new transfer oscillator box in place of the existing one. If this occurs, either try to fit the new transfer oscillator printed circuit board into the old sheet metal housing or contact the Alfred Electronics Customer Service Department in Palo Alto, California for detailed procedures.

Replace the original top and bottom covers and the left and right side handle assemblies using the original hardware. Type the model and serial number of the instrument in the spaces provided on the new identification label and affix this label to the rear panel of the Model 650. The adhesive on the back of the label can be activated by brushing it with acetone or the label can be secured to the instrument with rubber cement.

With these modifications installed, the Model 650 Sweep-Oscillator Main Frame is now compatible with the Model 9510/9511 Control System as well as with all standard Alfred plug-in units.

SECTION 6 - PARTS LIST FOR RETRO-FIT KIT, P/N 951717

QTY	ALFRED PART NO.	DESCRIPTION
1	903817	Rear Panel
1	903862	Rear Panel Cover Plate
1	906277	Relay Tie Point Bracket
1	81-20	Diode, 1N4385
1	106-42	Relay, DPDT, 12VDC Coil
1	133-13	Connector, 4 Pin Female
1	155-2	Terminal Strip, 1 Lug
1	155-3	Terminal Strip, 2 Lugs
1	192-11	Identification Label
20"	202-4	Wire, 24 AWG, White/Orange
20"	203-4	Wire, 24 AWG, Orange
22"	209-34	Cable, Shielded, 4 Conductor
1	301-9	Nut, 3-48 x 3/16
5	302-1	Nut, 6-32 x 5/16 (with Lockwasher)
1	306-13	Lockwasher, #3
2	311-1	Flat Washer, #6
1	346-2	Plastic Cable Clamp, 3/16"
1	346-3	Plastic Cable Clamp, 1/4"
1	389-30	Screw, 6-32 x 1/2"
1	389-31	Screw, 6-32 x 5/8"
16"	392-7	Sleeving, Gray, 1/8"
1"	392-18	Heat Shrinkable Tubing, 1/8"
1	396-1	Terminal Lug, #4

SECTION 6 - PARTS LIST FOR RETRO-FIT KIT, P/N 951717 (continued)

QTY	ALFRED PART NO.	DESCRIPTION
6	14-30	Capacitor, Mylar, .1 MF, 100 VDC
1	12-15	Capacitor, Disc Ceramic, .002 MF , 1 Kv
1	41-680K	Resistor, 680K ohm ± 10%, 1/2 watt
1	41-6.8M	Resistor, 6.8 Megohm ±10%, 1/2 watt
3	81-132	Diode, 1N914
4	81-188	Transistor, 2N3643
1	81-190	Diode, 1N270
1	81-220	Zener Diode, 17 volt ±5%, 1N5247B
18"	215-903	Wire, 22 AWG, White/Black/Orange
1	950635	Transfer Oscillator Assembly (if required)

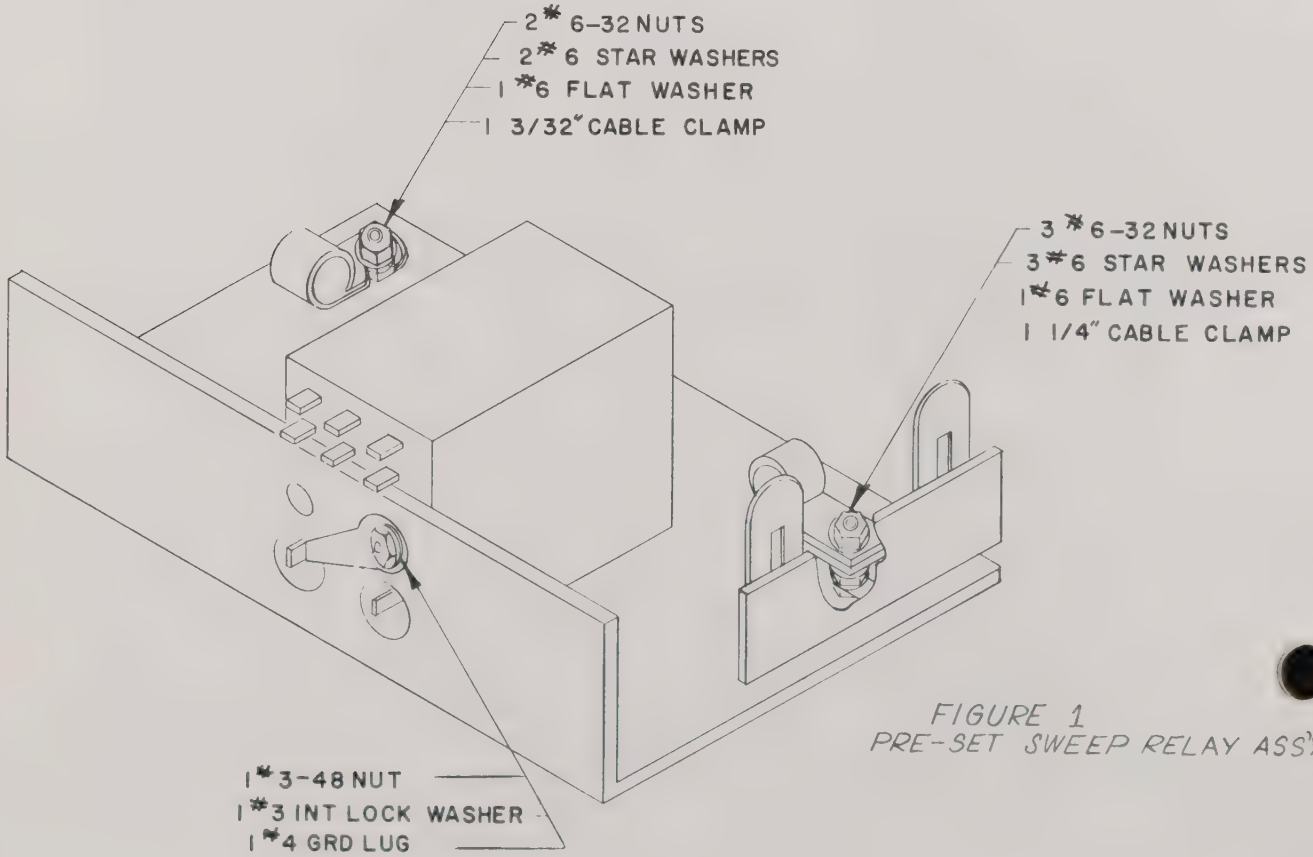

2 * 6-32 NUTS
2 * 6 STAR WASHERS
1 * 6 FLAT WASHER
1 3/32" CABLE CLAMP
3 * 6-32 NUTS
3 * 6 STAR WASHERS
1 * 6 FLAT WASHER
1 1/4" CABLE CLAMP
1 * 3-48 NUT
1 * 3 INT LOCK WASHER
1 * 4 GRD LUG

FIGURE 1
PRE-SET SWEEP RELAY ASSY

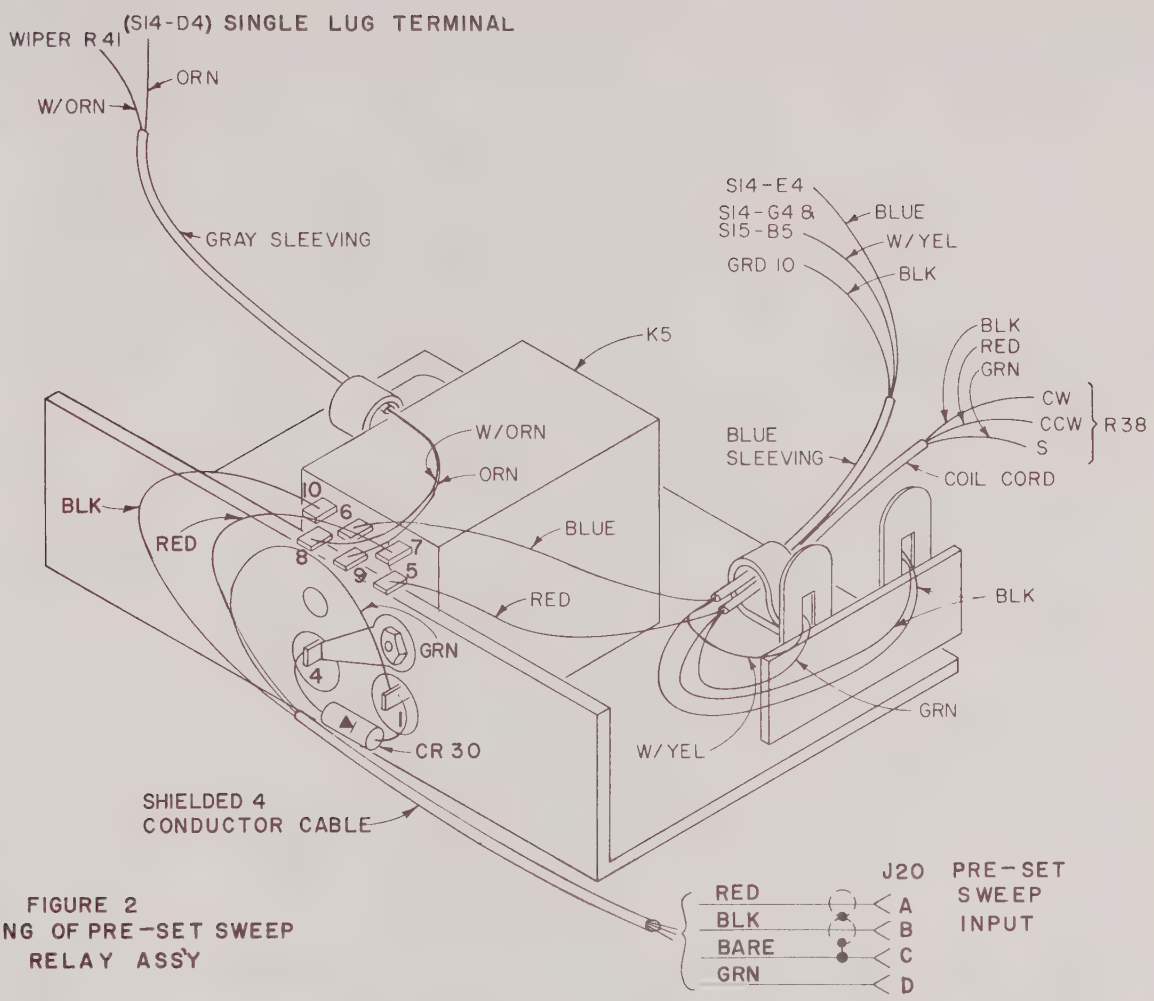


FIGURE 2
WIRING OF PRE-SET SWEEP
RELAY ASSY

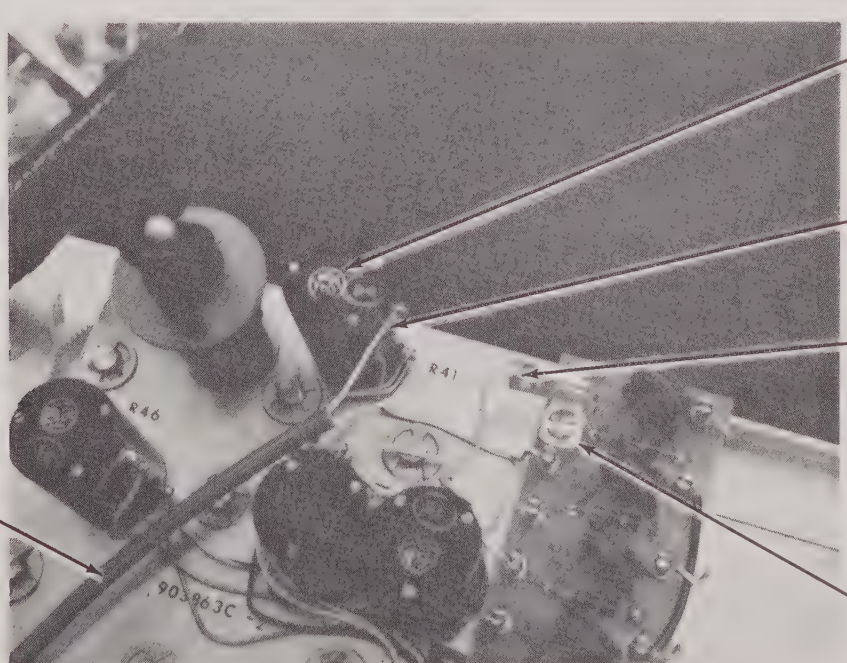


FIGURE 3. INSTALLATION OF SINGLE LUG TERMINAL STRIP ON FRONT PANEL

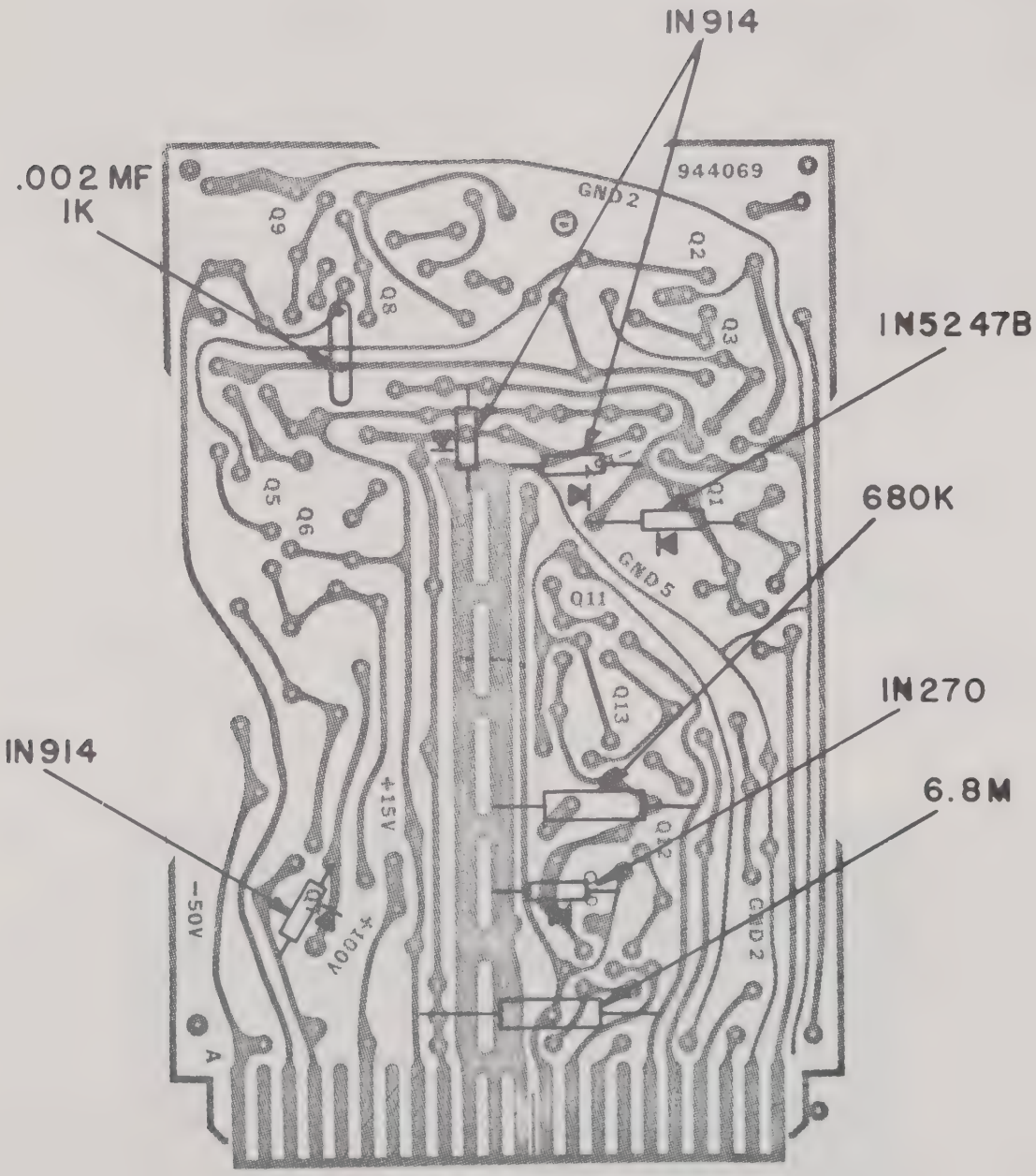


FIGURE 4

MODIFICATIONS TO CATHODE SUPPLY
PRINTED CIRCUIT BD.
INSTALL THE ADDITIONAL COMPONENTS IN THE
APPROXIMATE POSITION SHOWN ABOVE.

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SECTION 1

GENERAL INFORMATION

1.1 THE MODEL 9510/9511 MULTI-BAND SWEEP OSCILLATOR SYSTEM.

Your new Alfred multi-band oscillator system provides sweep coverage of the complete range from 250 MHz to 40 GHz or any portion thereof. It includes a basic Model 650 Sweep Oscillator, any combination of 650 Series Plug-in Oscillator Units, the Model 9510 push button Control Unit, and one or more Model 9511 Plug-in Container Units.

This system eliminates the need for manual installation of RF plug-in heads and the assembly and disassembly of associated microwave equipment as you change from one frequency band to another. Frequency coverage of the system is easily expanded with additional Model 9511 Container Units and Plug-in Oscillators.

1.2 THE MODEL 9510 CONTROL UNIT.

The Model 9510 Control Unit plugs into the front panel opening of the Alfred Model 650 Sweep Oscillator. It includes 10 push buttons which select any one of up to 10 Plug-in Oscillator heads to provide RF power output. A panel light adjacent to each push button indicates which of the plug-in oscillators is in use. A rear panel connector may be used for remote programming or actuating external equipment such as Traveling Wave Tube Amplifiers, RF Switches, or microwave components. Switching between any two bands can be accomplished in one second.

1.3 THE MODEL 9511 PLUG-IN CONTAINER UNIT.

Each Model 9511 Container Unit houses two Model 650 Series Oscillator Plug-in Units. A multi-band frequency dial, calibrated directly in frequency, is provided for the Model 650 to permit straightforward selection of sweep limits and single frequencies for any frequency range selected. Thus, broadband ($F_1 \rightarrow F_2$) sweep, narrow-band ($F_o \pm \Delta F$) sweep, and up to 5 single frequencies in each band may be set-up directly in GHz without need for conversion.

Broadband sweep limits or a single frequency may alternately be pre-programmed independently for each frequency range using the individual calibrated "start" - "stop" controls found on the front panel of the Model 9511. This feature provides important flexibility, as in straddle-band test set-ups. In all other respects, operation is the same as if the Plug-in Oscillator were used in the Model 650.

1.4 EACH PLUG-IN UNIT CAN BE OPERATED INDEPENDENTLY IN DIFFERENT STANDBY MODES.

The Model 9511 Container Units allow each Plug-in Oscillator in the system to be independently operated in the standby "on" or "off" condition. In "standby on", the BWO heater is hot and that plug-in unit is ready for immediate selection. To minimize cathode deterioration and thus preserve the life of the BWO, the helix/cathode high voltage is left on in the "standby on" mode. With this arrangement, continuous dissipation of space charge about the cathode yields 10 to 15% longer BWO life. All BWO tubes in "standby on" condition are biased to cut off RF output until selected for use, and switching time from selection to full-on is less than 1 second.

In all plug-ins being operated in "standby off" mode, the BWO tube heaters are de-energized until selected. Plug-in head selection when in the "standby off" mode is still automatic, but turn-on of RF output is delayed approximately 90 seconds to allow for BWO heater warm-up. This permits energizing the heater only when actually in use to conserve the BWO warranty coverage.

1.5 APPLICATIONS.

This system is a simple and economical way to obtain automatic swept-frequency coverage of the complete uhf and microwave spectrum, or of any desired individual bands or frequencies. Its compact size, the use of standard Sweep Oscillator modules, and provision for local or remote programming permits flexible system integration into an unlimited variety of test instrumentation complexes, with a wide range of test automation capabilities. You may start with only a few Oscillator Plug-in units and expand to full-spectrum coverage as your test requirements grow. The Model 9510/9511 system has many applications in production testing, system development, and general purpose laboratory use.

1.6 SYSTEM INSTRUCTION MANUALS.

This manual is intended to serve as an overall system manual for the multi-band Sweep Oscillator System consisting of a Model 650, a Model 9510, and one or more Model 9511 units containing Model 650 Oscillator plug-in units. This manual contains descriptive material, operating instructions, and maintenance information for the complete system, and detailed theory and maintenance information for the Model 9510 and 9511. (Detailed operating instructions for the Model 9510 and 9511 are included as part of the system operating instructions.)

Detailed operating instructions for the Model 650, covering the various modes of operation of it and its plug-in units, and detailed theory and maintenance for the Model 650 are covered in the Model 650 Instruction Manual which is supplied with the Model 650. (It is included in this System Manual following the pages covering the System and the Model 9510/9511, if the Model 650 is shipped with the Model 9510/9511 system.) Detailed theory and maintenance instructions for the Model 650 Oscillator Plug-in units are covered in one or more Model 650 Plug-in Unit Instruction Manual(s) (depending upon the types of plug-in units involved) which are normally supplied with the individual plug-in units. Manuals for plug-in units included in the system and auxiliary equipment furnished with the system are either furnished separately or bound in the rear of this manual.

1.7 LIMITATION ON USE OF CERTAIN EARLY-PRODUCTION OSCILLATOR PLUG-IN UNITS.

With certain early-production plug-in units having unshielded Stewart BWO tubes, there may be a degradation in power output when operated in the Model 9510/9511 system. All plug-in units having Varian BWO tubes, and later-production units having Stewart BWO tubes will provide rated power output.

TABLE 1.1 SPECIFICATIONS FOR MULTI-BAND SWEEP OSCILLATOR MODEL 9510/9511

A. SPECIFICATIONS-MODEL 9510 CONTROL UNIT

Controls:	10 push buttons for selecting any one of up to 10 Plug-in Oscillators mounted in Model 9511.
Installation:	Unit is installed into plug-in unit opening in the front panel of the Alfred Model 650 Sweep Oscillator. Required control signal output interconnecting cable is provided with each Model 9511.
Switching Time:	To any Plug-in Oscillator in "standby on" mode, less than 1 second. In "standby off", approximately 90 seconds. (Standby "on" or "off" mode is selected independently for each Plug-in Oscillator using controls on Model 9511.)
Remote Operation:	Remote selection of frequency range is accomplished by momentarily connecting one terminal of a rear-mounted Amphenol type 57-40140 connector to ground. Control pin voltage is normally -7 volts. (Mating Amphenol type 57-30140 connector supplied.)
Accessories Supplied:	A multi-band frequency dial plate for the Model 650, calibrated in GHz for all standard Plug-in Oscillator frequency ranges, is provided with each Model 9510.
Power:	All required power is supplied by the Model 650.
Weight:	5.5 pounds.

B. SPECIFICATIONS-MODEL 9511 PLUG-IN CONTAINER UNIT

Frequency Range:	250 MHz to 40 GHz. Each 9511 houses two Alfred 650 Series Plug-in Oscillators.
Sweep Oscillator Performance:	In accordance with Alfred 650 Series specifications.
Standby Selector Control:	Front panel push button selects range switching time of less than 1 second or approximately 90 seconds. In one-second position, the BWO/VTM heater is energized and ready for immediate operation.
Sweep Start/Stop Adjustment:	A front panel control provides for selection of sweep start/stop settings or single frequency output either by adjustment of F_1 and F_2 on the Model 650 frequency calibrated dial face or by adjustment of calibrated START and STOP controls on the Model 9511. One set of controls is provided for each Plug-in Oscillator unit.
Power:	115/220 volts, 50-400 Hz. Approximately 130 va. Units are interconnected through accessory outlets so that only one power connection per system is required.
Physical:	Removable cabinet sides permit installation in standard 19" rack. Height, 10-1/2"; width, 19"; depth behind panel 17-1/2"; total depth 19". Light grey panel, contrasting sides. Weight: approximately 32 pounds.

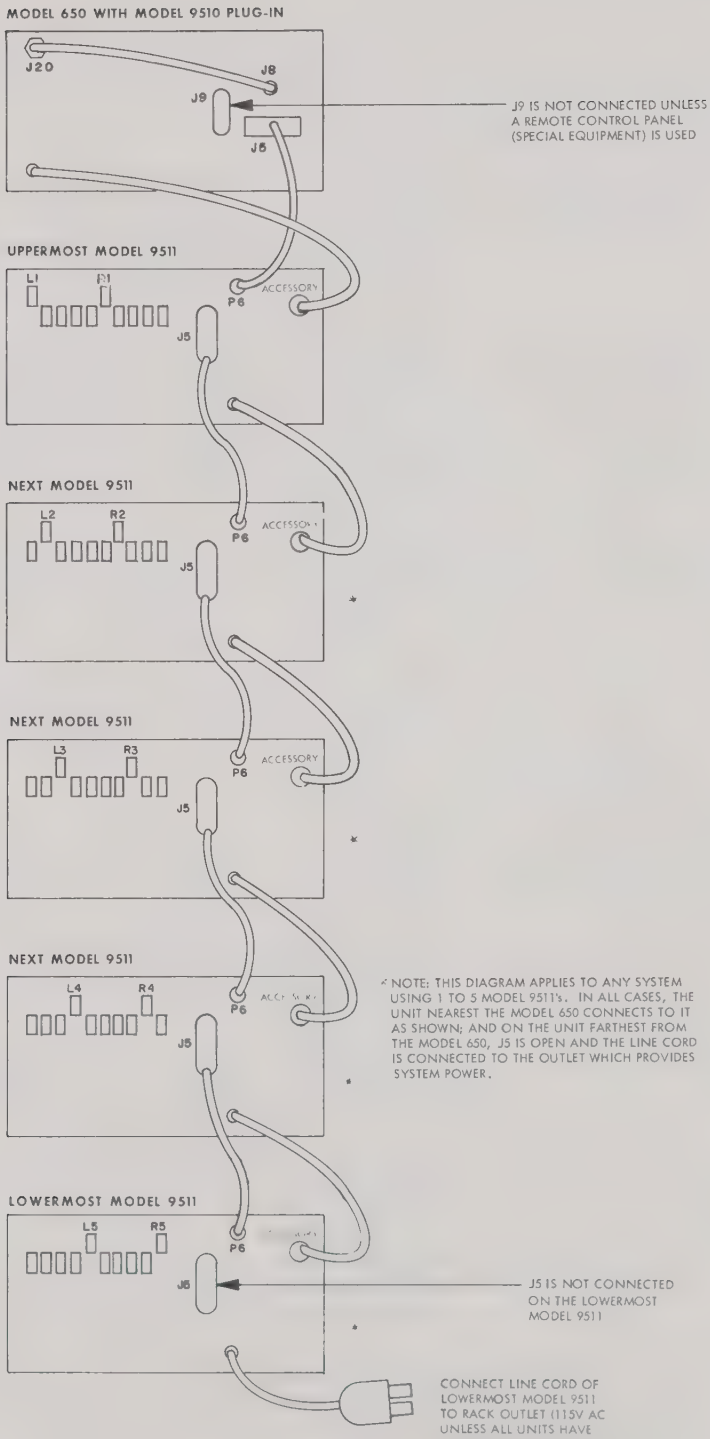


FIGURE 2-1. SYSTEM INTERCONNECTION DIAGRAM SHOWING CONNECTIONS AND SWITCH SET-UPS MADE ON THE REAR PANEL OF EACH UNIT.

SECTION 2

INITIAL INSTRUCTIONS

2.1 RECEIVING INSPECTION.

Upon receiving your Model 9510/9511 system, carefully unpack each unit and check for shipment damage. If some damage is evident, file a claim against the carrier. Refer to the Shipment Damage Claim form in the back of this manual.

CAUTION

THE OSCILLATOR PLUG-IN UNITS WHICH MAY BE INSTALLED IN THE MODEL 9511 UNITS CONTAIN A MICROWAVE TUBE WHICH IS EXTREMELY SENSITIVE TO FERROUS MATERIAL. USE ONLY NON-MAGNETIC SCREWDRIVERS AND OTHER TOOLS WHEN WORKING AROUND THE PLUG-IN UNITS, AND REMOVE YOUR WRIST WATCH TO AVOID MAGNETIC DAMAGE TO IT. WHEN REMOVED FROM THE MODEL 9511 UNITS, THE PLUG-IN UNITS SHOULD BE KEPT AT LEAST SIX INCHES FROM MAGNETIC MATERIALS.

2.2 SHIPPING SCREWS.

Each installed plug-in unit is secured to the Model 9511 for shipping with two screws located at the rear on each side of the cutout which exposes the rear of the plug-in unit. They are used to prevent plug-in damage. Prior to regular use of the unit, these screws should be removed unless the plug-in units are to be permanently stationed in the Model 9511. Two similar screws are installed in the rear of the Model 650 to retain the Model 9510 for shipping purposes, and should be removed unless the Model 9510 is to be permanently stationed in the Model 650. An aluminum shipping plate may be installed over the dial plate area of the Model 650 panel to protect the dial indicator mechanism. Remove this plate by removing its two attaching screws, and install the All-Band frequency dial plate shipped with the system.

2.3 POWER REQUIREMENTS.

All units are normally set up at the factory for operation at 105 to 125 V ac (115 V ac nominal) and 50 to 400 cps. However, provisions are provided for easy conversion to operation at 210 to 250 V ac (230 V ac nominal) as follows:

2.3.1 CONVERSION OF MODEL 650. With the top cover removed, locate the power switch labeled 115 VAC (Figure 5-1 of Model 650 manual). To convert to 230 V operation, remove plate and move the switch forward to its alternate position. Turn the plate over and replace it with 230 VAC showing. To reconvert for 115 V ac operation, reverse the above procedure. Use the proper fuse in accordance with the rear panel marking.

2.3.2 CONVERSION OF MODEL 9510. Since the Model 9510 receives all its power from the Model 650, conversion of the Model 650 as described in paragraph 2.3.1 provides suitable power for the Model 9510.

2.3.3 CONVERSION OF MODEL 9511. Each unit in the system must be converted as follows: With the top cover removed, locate the slide switch just to the left of the center front-to-rear deck. The switch should be in the forward position with the 115 V label exposed on the slider for 115 V operation. To convert to 230 V operation, move the switch to the rear position with the 230 V label exposed. To reconvert for 115 V ac operation, move the switch forward, to the 115 V position. Use a 2A fuse for 115V; a 1A fuse for 230V.

2.3.4 CONVERSION OF MODEL 650 PLUG-IN UNITS. Since each plug-in unit receives power from either the Model 650 or the Model 9511, conversion of those units in accordance with the above paragraphs will supply proper power to the Model 650 plug-in units.

2.4 INSTALLATION PROCEDURE.

2.4.1 ARRANGEMENT. The recommended arrangement for rack installation is to have the Model 650 at the top, with the Model 9511 units below, as shown in the title page illustration and in the interconnection diagram, Figure 2-1. The units may be arranged in other configurations, i.e., Model 650 below or at one side, but the Model 650 should be at one end of the system to permit interconnections as shown in Figure 2-1 unless special interconnecting cables are ordered. If a special remote control panel is included, it will be described in sheets added in the rear of this Model 9510/9511 manual.

CAUTION

IF A MODEL 650 S/N 1680 OR BELOW IS TO BE USED WITH A MODEL 9510/9511 SYSTEM BEING SET UP IN THE FIELD, THE MODEL 650 MUST BE RETROFITTED FOR COMPATIBILITY WITH THE MODEL 9510/9511. Instruments which have been retrofitted can be identified by the presence of J20 in the upper left corner of the Model 650 rear panel. Request a free retrofit kit #951717 with instructions from the factory. Be sure to include the S/N of the 650 to be modified. (Model 650 Instruments S/N 1681 and up are compatible without modification.)

2.4.2 CHASSIS GROUNDING. Each Model 9511 and the Model 650 have a three-conductor power cord and a three-prong plug, which grounds each instrument when the line cord supplying system power (see Figure 2-1) is plugged into an appropriate rack power source receptacle. If a three-prong to two-prong adapter is used, make sure the unit is properly connected to ground by grounding the adapter pigtail lead.

WARNING

FAILURE TO PROPERLY GROUND THE SYSTEM CAN DEGRADE ITS PERFORMANCE AND STABILITY, AND COULD ALLOW AN ABOVE-GROUND POTENTIAL TO BUILD UP ON THE CHASSIS, WHICH COULD BE DANGEROUS TO OPERATING PERSONNEL.

2.4.3 COOLING. The system can be mounted in any standard rack configuration without special regard to cooling provisions. No positive ventilation system is required. When the units are rack-mounted, the extension of each panel beyond the chassis height will provide adequate separation when units are mounted with panels flush. For cabinet-mounted units, adequate space should be provided at the top, rear and bottom of each Model 9511 and the Model 650 to allow convection air flow for cooling purposes. It is desirable to provide one inch at the top and one-half at the bottom.

2.4.4 INSTALLATION INSTRUCTIONS. If the units are cabinet mounted, the cabinets may be stacked with the rubber feet providing adequate separation, and connections made between units as shown in Figure 2-1 and itemized in paragraph 2.7. If the units are to be rack-mounted with the handle sides removed, the Model 650 and each Model 9511 requires 10-1/2" height in a 19" rack. The rack must provide at least 21" behind the panel to allow room for rear connections. Proceed as follows for rack mounting:

a. Measure and mark-off the 10-1/2" space to be occuppied by the Model 650 and each Model 9511.

b. Install the Model 650 in the upper space (unless a special configuration is desired).

c. Install each Model 9511 unit in the spaces below the Model 650 (unless a special configuration is desired).

d. Close off the remainder of the rack front with blank panels if desired.

e. Install plug-in units as necessary (if not already installed) in accordance with paragraph 2.5.

f. Install the Model 9510 into the plug-in unit opening of the Model 650 (if not already installed) in accordance with paragraph 2.6.

g. Make system interconnections as described in paragraph 2.7.

h. Set up PLUG-IN SET UP SELECTION slide switches in accordance with paragraph 2.8.

2.5 INSTALLATION, REMOVAL, AND INTERCHANGING OF PLUG-IN UNITS IN THE MODEL 9511 CONTAINERS.

CAUTION

TURN SYSTEM POWER OFF BY TURNING THE MODEL 650 POWER SWITCH OFF AND WAITING 15 SECONDS BEFORE REMOVING ANY INSTALLED PLUG-IN UNITS OR INSERTING ANY OTHER PLUG-IN UNITS. THIS WILL ALLOW ADEQUATE TIME FOR DECAY OF THE HIGH VOLTAGE POWER SUPPLIES. THEN CARRY OUT THE STANDARD TURN-ON PROCEDURE.

2.5.1 REMOVAL OF A PLUG-IN UNIT FROM THE MODEL 9511. To remove a plug-in unit from the Model 9511, release the plug-in unit's panel LOCK knob by turning fully CCW, and then pull the unit out of the Model 650 by pulling on the LOCK knob.

2.5.2 INSTALLATION OF A PLUG-IN UNIT IN THE MODEL 9511. To install a plug-in unit in the Model 9511, first make sure the plug-in unit LOCK knob is turned fully CCW so the lock arm will clear the Model 9511 panel opening and will enter far enough to actuate the safety interlock switch. Then insert the plug-in unit through the Model 9511 panel and lock in position by pressing in on the LOCK knob and turning it fully CW.

NOTE: Since an all-band frequency dial plate is supplied with the system, the individual frequency dial plate for each plug-in unit may be left attached to the underside of the storage compartment door in the top of the plug-in unit, using the knurled screws which are captive to the plate.

2.5.3 INTERCHANGING PLUG-IN UNITS IN THE MODEL 9511. To interchange plug-in units, follow the procedure of paragraphs 2.5.1 and 2.5.2 above.

2.6 INSTALLATION OR REMOVAL OF THE MODEL 9510 FROM THE MODEL 650 PANEL PLUG-IN OPENING.

2.6.1 INSTALLATION OF MODEL 9510. If the Model 650 is in operation, turn its POWER switch off and wait 15 seconds. Then to install the 9510, follow the procedure of paragraph 2.5.1 to remove an oscillator plug-in unit from the opening (if necessary) and to install the Model 9510. The Model 9510 Lock knob is at the top of its panel.

2.6.2 REMOVAL OF MODEL 9510. If the system is in operation, turn the Model 650 POWER switch off and wait 15 seconds. Then check that all interconnection cables are disconnected from the rear of the Model 9510. Follow the procedure of paragraph 2.5.1 to remove the Model 9510. The Model 9510 Lock knob is at the top of its panel.

NOTE: If the Model 9510 is removed, the Model 650 can be operated in the normal manner with any 650 series plug-in unit.

2.7 SYSTEM INTERCONNECTIONS (See Figure 2-1).

Make connections as follows:

NOTE: In the following procedure the Model 9511 nearest the Model 650 will be referred to as the "first" Model 9511; the remaining Model 9511 units will be referred to as the "second", "third", "fourth", and "last" Model 9511, proceeding away from the Model 650. If a system has fewer than five Model 9511's, skip those steps pertaining to units not present.

a. Check that the Model 650 POWER switch is in the off position.

b. Connect the 4-terminal connector J8 on the rear of the Model 9510 to the similar 4-terminal connector at the upper left rear corner of the Model 650, (not to the remote FREQ. CONTROL jack on the upper right) with the cable assembly (P/N 990254) supplied.

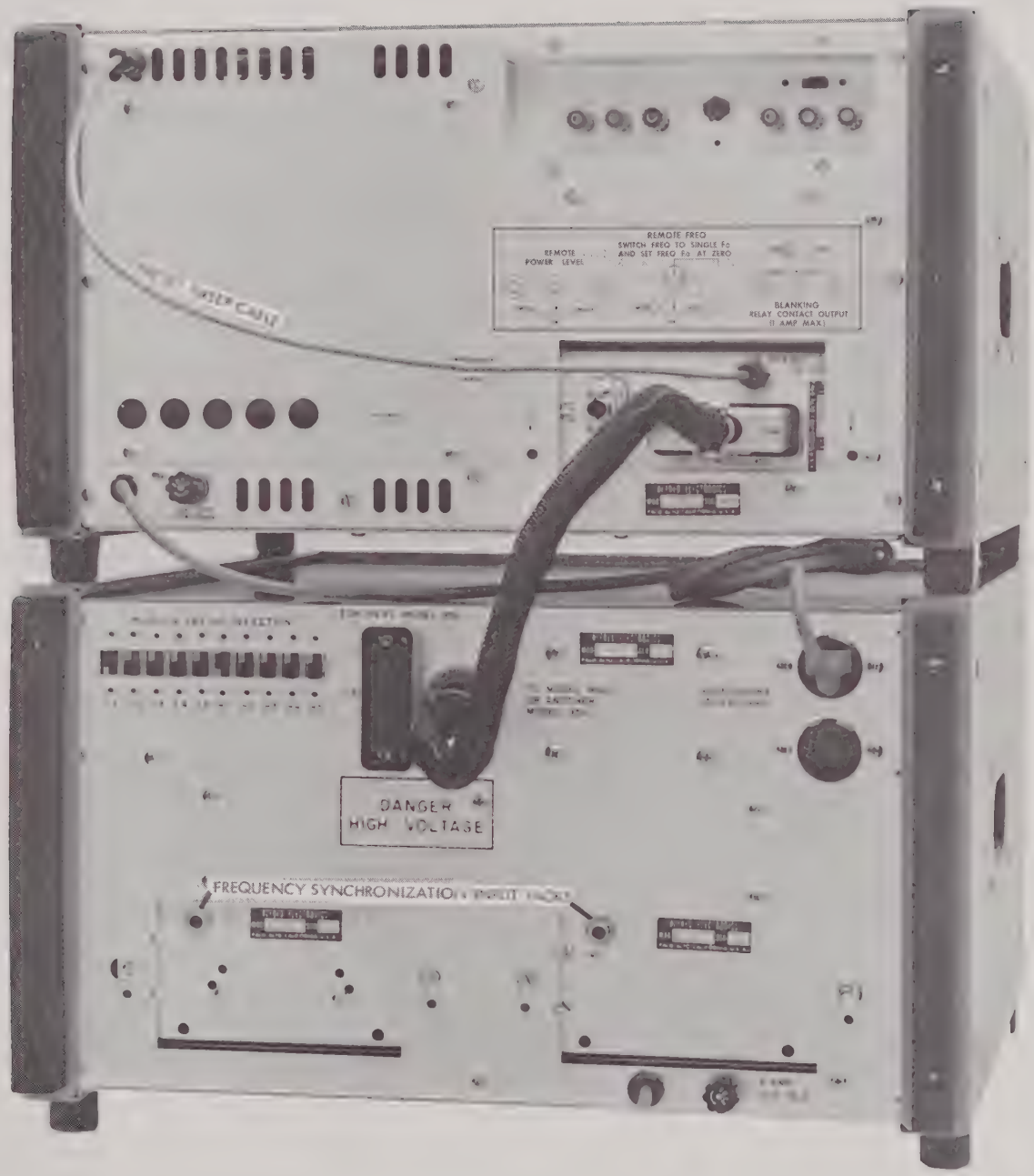
c. Connect the Model 650 line cord to the rear ACCESSORY receptacle on the first Model 9511.

d. Connect the large pigtail cable from the first Model 9511 (P6) to J5 on the rear of the Model 9510. See that all pins are aligned; then tighten both connector lock screws to secure the connection.

CAUTION

P6 PINS MUST BE STRAIGHT BEFORE CONNECTING TO J5

e. Connect the line cord of the first Model 9511 to the rear ACCESSORY receptacle on the second Model 9511.



NOTE: THE SYSTEM SHOWN CONSISTS OF A MODEL 650 (TOP) CONTAINING A MODEL 9510 PLUG-IN, AND A MODEL 9511 (BOTTOM) CONTAINING TWO MODEL 650 PLUG-IN UNITS. MORE MODEL 9511's MAY BE ADDED, UP TO A TOTAL OF FIVE.

FIGURE 2-2. REAR PANEL VIEW OF TYPICAL MODEL 9510/9511 SYSTEM.

f. Connect the plug (P6) on the cable captive to the second Model 9511 to J5 on the first Model 9511. See that all pins are aligned; then tighten both connector lock screws to secure the connection.

g. Connect the line cord of the second Model 9511 to the rear ACCESSORY receptable on the third Model 9511.

h. Connect the plug (P6) on the cable captive to the third Model 9511 to J5 on the second Model 9511. See that all pins are aligned; then tighten both connector lock screws to secure the connection.

i. Connect the line cord of the third Model 9511 to the rear ACCESSORY receptacle on the fourth Model 9511.

j. Connect the plug (P6) on the cable captive to the fourth Model 9511 to J5 on the third Model 9511. See that all pins are aligned; then tighten both connector lock screws to secure the connection.

k. Connect the line cord of the fourth Model 9511 to the rear ACCESSORY receptacle on the last Model 9511.

l. Connect the plug (P6) on the cable captive to the last Model 9511 to J5 on the fourth Model 9511. See that all pins are aligned; then lock screws to secure the connection.

m. Connect the line cord of the last Model 9511 to suitable A.C. power mains. The outlet should provide a third-prong ground connection in accordance with paragraph 2.4.2 and should be able to provide up to 10 amps to the system.

2.8 SET-UP OF PLUG-IN SET UP SELECTION SWITCHES (See Figure 2-1).

The PLUG-IN SET UP SELECTION slide switches (labeled L1 through L5 and R1 through R5) are located on the rear of each Model 9511. They control which of the Model 9510 push buttons operates the left-hand and right-hand plug-in unit (viewed from front panel) within each Model 9511. The switches labeled "L1" through "L5" correspond to the push buttons labeled "LEFT SIDE" - "1" through "5" on the Model 9510 panel, and the switches labeled "R1" through "R5" correspond to the push buttons labeled "RIGHT SIDE" - "1" through "5" on the Model 9510 panel. On each Model 9511, the one L switch and R switch corresponding to the button desired for control of the left-hand and right-hand plug-in unit from the Model 9510 panel should be in the upper position. All other switches should be in the lower position. Normally, L1 and R1 are used for the uppermost 9511, L2 and R2 for the next lower, L3 and R3 for the next lower, etc., as illustrated in Figure 2-1. The L or R switch corresponding to each button should be raised only on one Model 9511. If the same numbered switch is raised on two or more units, only the unit nearest the Model 9510 will be energized when the corresponding button is pressed.

If it desired to have frequency control in sequential bands, and the plug-in units have not been installed in a corresponding pattern, these switches can be changed from the "normal" program to accomplish the desired system set-up, the only restriction being that L buttons on the Model 9510 panel can only control plug-in units in the left-hand openings of the Model 9511 units, and R buttons on the Model 9510 can only control plug-in units in the right-hand openings of the Model 9511 units. For example, if it is desired that the LEFT 1 BUTTON control the left-hand plug-in unit in the third Model 9511, the rear L1 switch would be raised on that Model 9511 in lieu of any other, and one of the other rear "L" switches would be raised on the first Model 9511 instead of L1.

To set up the system with the normal pattern, proceed as follows (see Figure 2-1):

a. Switch L1 and R1 up and the other switches down on the first Model 9511.

b. Switch L2 and R2 up and the other switches down on the second Model 9511.

c. Switch L3 and R3 up and the other switches down on the third Model 9511.

d. Switch L4 and R4 up and the other switches down on the fourth Model 9511.

e. Switch L5 and R5 up and the other switches down on the last Model 9511.

2.9 INSTALLATION AND CALIBRATION OF ALL-BAND FREQUENCY DIAL PLATE.

Install the All-band frequency dial plate into the calibrated position on the Model 650 front panel as shown in Figure 3-1 of the Model 650 Instruction Manual. To calibrate the installed position of this plate, note that at the low-frequency end of the plate, at both top and bottom, there are calibration markers consisting of a transparent circle partially bisected by the black line which denotes the low-end frequency. The proper calibrated position of the dial plate is with these circles positioned so they are centered on the white line behind the plate (on the dial plate area of the panel). This aligns the low-end frequency marks with these white calibration lines. Check whether the dial plate is installed in this calibrated position. If necessary, loosen the two attaching knurled thumb screws and move the frequency dial plate sideways as required to achieve this calibrated alignment. Then retighten the two knurled thumb screws. The instrument is now calibrated to any frequency range shown on the all-band dial plate.

2.10 INCOMING INSPECTION TEST.

CAUTION

MANY INTERNAL ADJUSTMENTS LOCATED WITHIN THE MODEL 650 AND MODEL 9511 CHASSIS ARE CRITICAL. THEY HAVE BEEN CAREFULLY FACTORY-ADJUSTED PRIOR TO SHIPMENT AND SHOULD NOT NEED FIELD ADJUSTMENT. BECAUSE OF THE INTERACTION OF THESE ADJUSTMENTS A COMPLETE REALIGNMENT MAY BE REQUIRED IF THEY ARE DISTURBED. REFER TO SECTION 5 OF THIS MANUAL BEFORE TOUCHING ANY ADJUSTMENTS.

The following inspection test may be performed prior to regular operation of the multi-band system. In each step, leave switch settings as made previously unless instructed otherwise.

2.10.1 FREQUENCY CHECK.

a. Make the following panel control settings on the Model 650:

FREQUENCY Mode Selector to SINGLE

SINGLE Frequency Selector to F_o
MODULATION Selector to AM OFF
F_o FREQUENCY indicator to the low-end frequency on dial
F_1 FREQUENCY indicator to 0 (low end of scale)
F_2 FREQUENCY indicator to 100 (high end of scale)
FREQUENCY RETRACE to OFF
SWEEP TIME to .01 second; and concentric VARIABLE Control fully clockwise (CAL position)
SWEEP TRIGGER Selector to LINE
Turn POWER switch to ON

NOTE: A time delay relay delays application of high voltage for approximately 60 seconds after the power switch is turned on. This is to allow a brief warm-up period. If the ac power is off for even an instant, the normal 60-second delay will occur before the high voltage returns after turn-on.

b. Press both PLUG-IN STANDBY buttons on each Model 9511 to achieve Standby ON mode (PLUG-IN STANDBY light on) in each plug-in unit. Each STANDBY light will glow dimly until the Model 9511 warm-up delay period of about 90 seconds is completed. Check that PRESET SWEEP is off on each unit.

c. Make the following control settings on each plug-in unit:

RF OUTPUT switch to UNLEVELED
POWER LEVEL control to MAXIMUM clockwise position

d. Connect the RF OUTPUT connector of the first plug-in unit to be tested through a suitable frequency meter and attenuator pads to a video detector. Connect the detector output to the vertical channel of an oscilloscope. Set the scope for self-triggering; but for use in future steps, connect the SWEEP OUTPUT jack to the horizontal deflection channel of the oscilloscope.

CAUTION

THE RF POWER OUTPUT CAN BE AS GREAT AS 100 mw. DO NOT EXCEED THE MAXIMUM POWER RATING OF THE DETECTOR. USE SUITABLE ATTENUATOR PADS TO REDUCE THE OUTPUT POWER AND THUS PROTECT THE DETECTOR.

e. Press the LEFT SIDE or RIGHT SIDE button on the Model 9510 corresponding to the plug-in unit to be tested.

NOTE: If the Model 650 High Voltage trips off when a particular plug-in unit is selected, wait 10 seconds and press the RESET button on the Model 650 panel. This condition indicates that the plug-in selected has an older type anode overcurrent protection circuit installed in it. Contact your Factory Representative for the required updating kit. It will be supplied to you at no charge.

f. Check the frequency by observing the deflection of the scope trace as the frequency meter is moved through the output frequency. Repeat the check using several F_o settings across the band. The reading on the frequency meter should be within 1% of the frequency indicated on the proper scale of the all-band dial. If not, refer to Section 5 for recalibration.

g. On the Model 650 panel, change the FREQUENCY Mode Selector to SWEEP: $F_1 \rightarrow F_2$

NOTE: To check the sweep output voltage at the time the first plug-in unit is tested, temporarily connect an oscilloscope to the SWEEP OUTPUT jack using dc coupling. The signal observed should be a sawtooth with an amplitude of exactly 15 volts peak-to-peak. Then reconnect the video detector to the RF OUTPUT connector using suitable pads, as in step d, with the detector output connected to the vertical channel of an oscilloscope. Reconnect the SWEEP OUTPUT jack to the horizontal deflection channel of the oscilloscope.

h. Visually check the unleveled rf output across the band.

i. To check leveler performance if the unit has a "K" suffix, set the RF OUTPUT switch to LEVELED, and the RF SAMPLER switch to INTERNAL, and rotate the POWER LEVEL control counterclockwise until the rf output is leveled, at which time the UNLEVELED light will go out.

j. Visually check the leveled rf output across the band.

k. On the panel of the Model 9511 containing the plug-in unit being tested, make the following control changes for that plug-in unit:

PLUG-IN STANDBY button - push OFF
PRESET SWEEP button - push ON
PRESET SWEEP-START control to 0
PRESET SWEEP-STOP control to 100

l. Check the frequency at each end of the swept band by observing the wavemeter pip as displayed on the scope trace. The band limits should agree with those on the frequency dial plate within ±5%.

m. Turn the PRESET SWEEP-STOP control for the plug-in unit being tested to 0, and slowly rotate the PRESET SWEEP-START control through the band from 0 to 100, and check whether proper single-frequency output is obtained by observing the drop of the scope trace as the frequency meter is moved to track the control setting across the band. (Read frequency corresponding to each PRESET SWEEP control setting by correlation of the logging scale with the frequency band in use, on the dial plate.)

n. On the Model 9510, press the LEFT SIDE or RIGHT SIDE button corresponding to the next plug-in unit being tested. Then turn the Model 650 FREQUENCY Mode Selector to SINGLE. Then repeat steps d through m above for this next plug-in unit.

o. Repeat step n for each other plug-in unit being tested.

p. While testing the last plug-in unit, proceed to steps q through u below to test the remaining significant performance features of the Model 650.

q. Make the following panel control settings on the MODEL 650.

MODULATION Selector to SQ WAVE

r. Observe the rf output on the oscilloscope. The display should be keyed on and off in a symmetrical square wave pattern.

s. Turn the Model 650 TRIGGER Selector switch to FREE RUN. The rf output, as observed on the oscilloscope, should continue.

t. Turn the Model 650 TRIGGER Selector switch to MANUAL.

u. Press the button in the TRIGGER Selector switch. One sweep should be obtained after each push of the button.

v. Turn the Model 650 POWER switch off.

2.11 STORAGE OF PLUG-IN UNITS REMOVED FROM THE MODEL 650.

Always store an Oscillator Plug-in unit in a suitable container, such as the ALFRED Storage Container, Model 9000, or on wood and at least 6 inches from magnetic sources.

2.12 RETURNING ANY INSTRUMENT IN THE SYSTEM.

If it becomes necessary to return any unit of the system to ALFRED ELECTRONICS, authorization must first be obtained from our Sales Department.

When authorization is received, prepare the instrument for shipment using proper packaging techniques. Use shipping screws, installed through the holes in the rear of the cabinet, to secure plug-in units to be shipped in the Model 650 or Model 9511. (Ship plug-in heads separately if possible.) A protective shipping plate or a piece of cardboard should be placed over the dial plate area of the Model 650 for protection. A board or heavy cardboard buffer should be placed in front of the Model 650 or Model 9511 unit across the handles to protect the panel from blows against the container.

The instrument should be wrapped in a protective material such as polyethylene and heavy wrapping paper to protect against marring by the padding used in the container. A sufficient quantity of padding material, such as hair flex, should be placed all around the instrument for cushioning. If the original shipping container is not available, an equivalent rugged cardboard container or wooden crate should be used for the packing carton. Pack the instrument so that it cannot move around in the container. A letter containing all pertinent information should be included in the package, unless such a letter has previously been sent to our Sales Department.

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SECTION 3
OPERATION

3.1 FRONT PANEL CONTROLS.

A functional description of the front panel controls and indicators on the Model 9510 and Model 9511, and the multi-band dial provided for the Model 650, is given in Table 3-1. Refer to the Model 650 Instruction Manual for a functional description of controls on the Model 650 itself and on the Oscillator Plug-in units.

NOTE: THE SYSTEM SHOWN CONSISTS OF A MODEL 650 (TOP) CONTAINING A MODEL 9510 PLUG-IN, AND A MODEL 9511 (BOTTOM) CONTAINING TWO MODEL 650 PLUG-IN UNITS. MORE MODEL 9511's MAY BE ADDED, UP TO A TOTAL OF FIVE.

FIGURE 3-1. FRONT PANEL VIEW OF TYPICAL MODEL 9510/9511 SYSTEM.

TABLE 3.1 DESCRIPTION OF FRONT PANEL CONTROLS AND INDICATORS

	- MODEL 9510 -
LEFT SIDE and RIGHT SIDE Pushbutton Switches	When any switch is pressed, it de-activates the previously used plug-in unit, if any, and activates the plug-in unit corresponding to the newly-pressed switch. The correlation of switch numbers (1 thru 5) and plug-in positions is controlled by the ten ON-OFF slide switches on the rear of each Model 9511 container, and these are normally set up so the top plug-in unit on each side is #1, with numbers increasing toward the bottom of the rack. The selected plug-in unit will be under full control of the Model 650 panel controls - as though it were installed directly in the Model 650 plug-in opening - with the exception that if PRESET SWEEP has been turned on for the selected plug-in unit, the PRESET SWEEP controls over-ride the F_1 and F_2 controls on the Model 650 panel in the $F_1 \rightarrow F_2$ sweep mode only. Turn-on and switching time will be less than 1 second when the selected plug-in unit has been placed in the Standby On mode using the button adjacent to that plug-in unit on its Model 9511 container. Otherwise, turn-on and switching time will be approximately 90 seconds, to provide adequate warm-up of the BWO tube. The plug-in unit de-activated will be turned off unless the adjacent STANDBY button for that unit has been pressed to place it in Standby On mode at any time after turn-on of power to the system.
LEFT SIDE and RIGHT SIDE Indicator Lights	Glow to indicate which plug-in unit has been selected. The light for the selected plug-in unit glows brightly when rf output is being supplied from the unit. It glows dimly during the warm-up periods before rf output is supplied when the selected unit is not in the Standby On mode. If the light does not glow after the selector button is released, it indicates improper installation of the plug-in unit or if the plug-in set-up selection switches have been improperly set-up.
	- MODEL 650 -
Multi-band Frequency Dial Plate	Calibrated directly in GHz for each standard frequency band. Enables dial settings to be made at the exact frequencies desired for any plug-in unit selected without changing dial plates. Also includes a "logging" scale calibrated in % from 0 to 100% across the top to facilitate dial settings in terms of % of full band.
	- MODEL 9511 -
POWER ON Indicator Light	Indicates that power is applied to the container when system power is turned on by switching on the Model 650.
PLUG-IN STANDBY Pushbutton Switch	When pressed after system power is turned on, places the corresponding plug-in unit in Standby On mode with BWO heater voltage applied. At any time after the unit has been in this mode at least 90 seconds, instant turn-on to rf output (1 second) will be provided. Standby On mode continues after another plug-in unit has been selected. The button is a push-on, push-off sequential type, and to take the unit out of the Standby On mode at any time, merely press the button.
PLUG-IN STANDBY Indicator Light	Glows dimly when the corresponding plug-in unit has been in Standby On mode less than 90 seconds; glows brightly when the corresponding plug-in unit is warm and ready to provide instant rf output when selected. Off when the corresponding plug-in unit is not in Standby On mode.
UNIT SELECTED Indicator Light	Glows when the corresponding plug-in unit has been activated by pressing the proper button on the Model 9510. If the light does not remain on after the button is released, it indicates that the plug-in unit is inserted improperly or that the LOCK knob is not properly tightened.
PRESET SWEEP Pushbutton Switch	Can be pressed at any time after system power is turned on. Establishes a Preset Sweep mode of operation if the corresponding plug-in unit is selected and the Model 650 is set for $F_1 \rightarrow F_2$ broadband sweep. In this mode the adjacent PRESET SWEEP START and STOP controls over-ride the Model 650 F_1 and F_2 controls, so that different sweep limits can be established for each plug-in unit using this mode without altering the control settings on the Model 650 itself. The button is a push-on, push-off sequential type, and to take the unit out of Preset Sweep mode at any time, merely press the button.
PRESET SWEEP Indicator Light	Glows when Preset Sweep mode has been selected for the corresponding plug-in unit and the plug-in unit is operating.
PRESET SWEEP START-STOP Dial Controls	Establish the lower (START) and upper (STOP) limits of the preset sweep which is provided when the selected plug-in unit has been programmed to PRESET SWEEP mode and the Model 650 is set for $F_1 \rightarrow F_2$ sweep. Essentially, the START control setting over-rides F_1 on the Model 650, and the STOP control setting over-rides F_2. These controls are calibrated in % of full scale, corresponding to the "logging" scale on the dial faceplate. To select a particular frequency in any frequency band, merely note the logging scale % mark corresponding to that frequency on the proper scale of the multi-band frequency dial, and set the PRESET SWEEP control to the same %. The PRESET SWEEP controls can also be used to obtain manual sweep or an adjustable single frequency independently of the Model 650 controls, if the Model 650 is set for $F_1 \rightarrow F_2$ sweep. To do this, set the PRESET SWEEP - STOP control to 0, and use the PRESET SWEEP - START control to either manually sweep across the band or to set any desired single frequency. The instrument will resume automatic sweep when the PRESET SWEEP - STOP control is turned above 0 to a higher setting than the PRESET SWEEP - START control. When the selected plug-in unit is not in Preset Sweep mode the PRESET SWEEP controls are non-functional, and the plug-in unit is fully controlled from the Model 650 panel. The PRESET SWEEP should not be used if the Model 650 is set for some mode other than $F_1 \rightarrow F_2$ sweep.

3.2 REAR PANEL CONTROLS.

There are no rear panel controls on the Model 9510. The only rear panel controls on the Model 9511 are the PLUG-IN SET UP SELECTION slide switches labeled L1 through L5 and R1 through R5. These switches need only be used for initial set-up of the system. Within each Model 9511, they control which of the Model 9510 push buttons operates the left-hand and right-hand plug-in unit (viewed from front panel). The switches labeled "L1" through "L5" correspond to the push buttons labeled "LEFT SIDE" - "1" through "5" on the Model 9510 panel, and the switches labeled "R1" through "R5" correspond to the push buttons labeled "RIGHT SIDE" - "1" through "5" on the Model 9510 panel. The one L switch and R switch on each Model 9511 corresponding to the button desired for control of the left-hand and right-hand plug-in unit from the Model 9510 panel should be in the upper position. All other switches should be in the lower position. Normally, L1 and R1 are used for the uppermost 9511, L2 and R2 for the next lower, L3 and R3 for the next lower, etc.

3.3 REAR PANEL CONNECTORS.

A functional description of all rear panel connectors is given in Table 3.2.

TABLE 3.2 DESCRIPTION OF REAR PANEL CONNECTORS

Connector	Function
	- MODEL 9510 -
J5 - TO MODEL 9511	Accepts the cable from P6 of the nearest rack-mounted Model 9511, providing BWO power and control signal interconnections between the plug-in units and the Model 650 and 9510.
J8 - PRESET SWEEP TO MODEL 650	Connects to the PRESET SWEEP input 4-terminal connector added at the upper left rear corner of the Model 650, through a cable. Provides the frequency control signal to the Model 650 from the selected plug-in unit in Preset Sweep mode.
J9 - REMOTE CONTROL	Connects to an optional special Remote Control Panel through a cable, to permit remote operation of plug-in selection or to control peripheral equipment (such as TWT amplifiers) connected to the system.
	- MODEL 650 -
PRESET SWEEP INPUT	Connects to J8 of the Model 9510.
	- MODEL 9511 -
ACCESSORY 115/220 VAC	Accessory outlet which has power applied whenever the Model 9511 line cord is energized. Normally, the lowermost Model 9511 is the only unit of the system having its line cord connected to a rack outlet. The line cord of each of the other Model 9511 units connects to the ACCESSORY outlet of the Model 9511 below it, and the Model 650 line cord connects to the ACCESSORY outlet of the uppermost Model 9511. The ACCESSORY outlet is the only component receiving power in each Model 9511 when the Model 650 POWER switch is off. The remaining circuitry in each Model 9511 is protected by the 2 AMP-SLO BLO fuse on the rear panel and is energized automatically only when the Model 650 POWER switch is ON.
P6 - TO MODEL 9510 or ANOTHER MODEL 9511	Captive BWO power and control signal cable terminated in a connector. From the Model 9511 nearest the Model 650, this cable connects to J5 of the Model 9510. From each more distant Model 9511, the cable connects to J5 of the Model 9511 closer to the Model 650.
J5 - FOR NEXT MODEL 9511	Connector which accepts the captive cable from P6 of the next Model 9511 more distant from the Model 650. This connector is left open on the Model 9511 farthest from the Model 650 (normally the lowermost unit). WARNING THERE IS HIGH VOLTAGE PRESENT ON ALL EXPOSED CONNECTORS WHEN THE SYSTEM IS OPERATING.
2 AMP SLO-BLO	Protects all circuitry in the Model 9511 except for the ACCESSORY outlet, which is connected directly to the line cord.

3.4 INSTRUMENT TURN-ON PROCEDURE.

a. Check that the system interconnections and line power connections and rear panel PLUG-IN SET UP SELECTION switch settings have been made in accordance with Figure 2-1.

b. Check that the desired plug-in units have been inserted and locked into position in the plug-in openings in the Model 9511 units.

c. Check that the all-band frequency dial plate has been placed in the calibrated position on the Model 650 panel.

d. Turn the Model 650 POWER toggle switch ON.

e. The POWER ON indicator light should glow immediately. If not, check that the Model 9510 LOCK knob is properly tightened (it actuates an interlock switch).

f. After about 60 seconds, the HIGH VOLTAGE ON light should glow. Observe all high voltage precautions when the light is on.

g. Turn to the appropriate paragraphs below for the control settings and operating procedures for the desired mode of operation.

CAUTION

WHEN REMOVING OR INSTALLING ANY PLUG-IN UNIT IN ANY MODEL 9511, FIRST TURN THE SYSTEM OFF BY TURNING THE MODEL 650 POWER SWITCH OFF. THEN WAIT 15 SECONDS BEFORE REMOVING ANY INSTALLED PLUG-IN UNIT, TO PERMIT DECAY OF THE POWER SUPPLY VOLTAGES.

3.5 SELECTION OF "STANDBY ON" OR "OFF" CONDITION FOR EACH PLUG-IN UNIT.

3.5.1 GENERAL. If a switching time between plug-in units of ≈ 90 seconds can be tolerated, none should be placed in Standby On mode. If the first or only unit to be used in a particular test needs to be turned on without a 90-second turn-on delay, that one unit should be placed in Standby On mode. If several units in succession need to be turned on without a 90-second delay, those units all should be place in Standby On mode. In the case of several units being used in succession, an alternate standby procedure is to place the first one in Standby On mode at initial turn-on and then place each successive unit in Standby On mode shortly before it is needed in operation.

It is advantageous to leave each unit in Standby Off mode whenever possible because in that mode the BWO tube heater is de-energized until the plug-in unit is selected to provide rf output. Switching in the Standby Off mode is still automatic, but turn-on of output is delayed about 90 seconds to allow for heater warm-up. This permits energizing the BWO heater only when actually in use to conserve the BWO warranty.

In any plug-in unit in Standby On mode, the BWO heater is energized and the unit is thus ready for immediate selection without requiring warm-up time. Whenever any plug-in unit is placed in operation, the same BWO helix, cathode and voltages are applied to all plug-in units in the system. A grid voltage of -100 V and an anode-cathode clamp are applied to all plug-in units except the one selected for rf output, to cut off the BWO, eliminating cathode current and rf output from any other plug-in units which may be in Standby On mode. This application of helix/cathode high voltage minimizes cathode deterioration and thus helps preserve the life of the BWO in the Standby On mode. With this arrangement, continuous dissipation of space charge about the cathode yields 10 to 15% longer BWO life.

3.5.2 PROCEDURE FOR PLACING ONE OR MORE PLUG-IN UNITS IN "STANDBY ON" MODE. To do this, press the PLUG-IN STANDBY button adjacent to each affected plug-in unit on the panel of its Model 9511 container. When in the "on" position, the switch button will remain depressed. The PLUG-IN STANDBY light will glow dimly for the first 90 seconds or so during the heater warm-up period. The PLUG-IN STANDBY light will glow brightly after Standby On mode is achieved. Any switches left in the Standby On position when the system is turned off will remain in that position and automatically re-establish the Standby On mode for the corresponding units within 90 seconds after power is reapplied to the system.

3.5.3 PROCEDURE FOR SWITCHING ONE OR MORE UNITS OUT OF "STANDBY ON" MODE. To switch any unit from "Standby On" to "Standby Off", press the PLUG-IN STANDBY button. This push on - push off type button will protrude further from the panel when released to the "Off" position, and the adjacent PLUG-IN STANDBY light will go off.

3.6 SELECTION AND TURN-ON OF PLUG-IN UNITS TO PROVIDE RF OUTPUT.

3.6.1 GENERAL. Any plug-in unit may be selected to provide rf output at any time by pressing the corresponding LEFT SIDE or RIGHT SIDE button of the Model 9510. The programming of which button controls which plug-in unit is controlled by the PLUG-IN SET UP SELECTION switches on the Model 9511 rear panels as described in paragraph 2.8 and illustrated in Figure 2-1. Remote programming from a special panel or computer software can be provided on special order. Rf output will be supplied within 1 second after selection when the selected plug-in unit is in Standby On mode, and after about 90 seconds if the selected unit is not in Standby condition. If a button is pressed on the Model 9510 immediately after system turn-on, before the Model 650 has entered the the High Voltage On mode, the first part of the 90-second warm-up period of the plug-in unit will be concurrent with the remainder of the 60-second warm-up period of the Model 650, and rf output will be supplied from the selected plug-in unit after about 90 seconds.

NOTE: If the Model 650 High Voltage trips off when a particular plug-in unit is selected, wait 10 seconds and press the RESET button on the Model 650 panel. See paragraph 2.10.1-e.

3.6.2 PROCEDURE FOR TURNING ON RF OUTPUT FROM A PLUG-IN UNIT. To do this, push the LEFT SIDE or RIGHT SIDE button corresponding to the desired plug-in unit. The indicator light adjacent to the button will glow brightly when the selected plug-in unit is energized for rf output. The indicator light will glow dimly during warm-up period before rf output is supplied if the selected unit is not in Standby On mode. Switching is accomplished electronically in response to a momentary touch of the button, and it is not necessary to hold the button depressed regardless of standby condition. If two or more buttons are pressed simultaneously, the plug-in unit selected will be the one corresponding to the button released last. It is electrically impossible to select two or more plug-in units for simultaneous rf output.

NOTE: If the white plug-in unit indicator light on its Model 9511 does not glow when the unit is selected, check that the plug-in LOCK knob is tightened. Refer to Section 5 for trouble-shooting information if rf output is not obtained from the selected unit.

3.6.3 PROCEDURE FOR SELECTING RF OUTPUT FROM A DIFFERENT PLUG-IN UNIT. Push the button on the Model 9510 corresponding to the new selection. The system will automatically cut off rf output from the previous plug-in unit and supply output from the newly selected unit, either in 1 second or with a 90-second delay, depending upon the standby condition of the selected unit, as described in paragraph 3.6.2. The previously used plug-in unit will revert to the standby condition set by its individual PLUG-IN STANDBY button. If the unit were previously in Standby On mode to allow for quick selection, but it will not be re-selected right away, switch it to Standby Off mode using the control on the Model 9511 panel.

NOTE: If the Model 650 High Voltage trips off when a particular plug-in unit is selected, wait 10 seconds and press the RESET button on the Model 650 panel. See paragraph 2.10.1-e.

3.7 PROCEDURE FOR TURNING OFF RF OUTPUT FROM THE SELECTED PLUG-IN UNIT WITHOUT TURNING ON SOME OTHER UNIT.

3.7.1 GENERAL. Only when the system is initally turned on from the Model 650 POWER switch will the Model 9510 switching circuits be electrically "cleared" so that no plug-in unit is providing rf output. Once any plug-in unit has been selected to provide rf output, the Model 9510 controls can be used only to select some other unit.

There are three methods for turning rf output off without using the Model 9510 controls to select rf output from another plug-in unit. Use the one listed below which is most suitable for the particular situation.

3.7.2 PROCEDURE FOR TURNING OFF RF OUTPUT WHEN IT WILL NOT BE NEEDED FOR SEVERAL MINUTES OR MORE. Turn off the Model 650 POWER switch to shut off the system. This will conserve BWO life, and the system can be turned on again as desired by turning the Model 650 POWER switch ON and selecting the desired plug-in unit, following the procedure of paragraph 3.6.1.

3.7.3 PROCEDURE FOR TURNING OFF RF OUTPUT FOR SHORT DURATIONS. If it is desired to temporarily turn off rf output from the plug-in unit in use without switching to some other unit or turning off the system, turn the Model 650 FREQUENCY Mode Selector switch to the OFF position. This removes the rf output and keeps the selected plug-in unit in "standby" condition ready for instant use regardless of the condition of the PLUG-IN STANDBY switch for that plug-in unit on the adjacent Model 9511 panel. Thus, the Model 650 FREQUENCY Mode Selector switch may be placed in the OFF position until output connections are completed, and during desired downtime. RF OUTPUT is instantly restored when the FREQUENCY Mode Selector switch is set to any other position.

3.7.4 ALTERNATE PROCEDURE FOR TURNING OFF RF OUTPUT FOR SHORT DURATIONS ON SYSTEMS HAVING AN UNUSED (OPEN) POSITION IN ONE OF THE MODEL 9511'S,OR IN SYSTEMS HAVING LESS THAN 5 MODEL 9511'S. An alternate to the method described in paragraph 3.7.3 above for such systems is to push a button on the Model 9510 which "selects" an unused position. RF output can later be obtained by selecting the desired plug-in unit following the procedure of paragraph 3.6.2.

3.8 OPERATING PROCEDURE FOR SWEPT FREQUENCY OUTPUT CONTROLLED FROM THE MODEL 650.

Proceed as follows:

a. Turn on the system in accordance with paragraph 3.4.

b. Turn on the desired plug-in unit in accordance with paragraph 3.6.

c. Check that the PRESET SWEEP light is not on for the selected plug-in unit on its Model 9511 panel. Push the adjacent PRESET SWEEP button to obtain the "Off" condition if necessary.

d. Refer to Section 3 of the Model 650 Instruction Manual for detailed procedures covering the particular sweep mode desired. Paragraph 3.5 of that manual covers broadband,narrowband, and manual sweep modes. Use the Model 650 panel controls to operate the selected plug-in unit exactly as if the plug-in unit were installed directly in the Model 650.

e. Refer to later paragraphs in Section 3 of the Model 650 Instruction Manual for information on sweep time selection (paragraph 3.7), sweep trigger selection (paragraph 3.8), modulation provisions (paragraphs 3.9 through 3.11), use of markers (paragraph 3.13), retrace blanking provisions (paragraph 3.14), and auxiliary output signals (paragraph 3.15).

f. Make power level adjustments and leveling connections or control settings at the panel of the selected plug-in unit, following the procedure given in paragraph 3.12 of the Model 650 Instruction Manual for the leveling and power control mode desired.

3.9 OPERATING PROCEDURE FOR PRESET SWEEP OUTPUT CONTROLLED FROM THE MODEL 9511 CONTAINING THE SELECTED PLUG-IN UNIT.

Proceed as follows:

a. Turn on the system in accordance with paragraph 3.4.

b. Turn on the desired plug-in unit in accordance with paragraph 3.6.

c. Turn the Model 650 FREQUENCY Mode Selector switch to SWEEP $F_1 \rightarrow F_2$.

d. On the Model 9511 containing the selected plug-in unit, turn the PRESET SWEEP on for that unit by pushing the PRESET SWEEP button in to the "ON" position.

e. Set the PRESET SWEEP controls to the desired sweep band limits, with the START control set to a lower frequency than the STOP control. These controls may be adjusted to different band limits at any time. If the Model 650 OUTPUT SWEEP signal is used to drive the horizontal axis of an oscilloscope display,the band swept will be displayed over the full width of the CRT,so that narrow-band display expansion is automatically provided when narrow PRESET SWEEP band limits are set. The 0 to 100 panel markings on the PRESET SWEEP controls correspond to the scale divisions on the frequency dial plate "logging" scale,and can be converted to frequency by visually correlating the "logging" scale with the frequency scale for the band in use.

f. Refer to later paragraphs in Section 3 of the Model 650 Instruction Manual for information on sweep time selection (paragraph 3.7), sweep trigger selection (paragraph 3.8), modulation provisions (paragraphs 3.9 through 3.11), use of markers (paragraph 3.13), retrace blanking provisions (paragraph 3.14), and auxiliary output signals (paragraph 3.15).

g. Make power level adjustments and leveling connections or control settings at the panel of the selected plug-in unit, following the procedure given in paragraph 3.12 of the Model 650 Instruction Manual for the leveling and power control mode desired.

h. If Preset Sweep mode output is desired from another plug-in unit, select that unit in accordance with paragraph 3.6.3 above, and carry out steps d through g above as necessary for the newly selected unit. Note that PRESET SWEEP control settings can be made in advance, as desired for each individual plug-in unit,to permit instant switching between selected sweep bands in each frequency range.

3.10 OPERATING PROCEDURE FOR SINGLE FREQUENCY OUTPUT CONTROLLED FROM THE MODEL 650.

Proceed as follows:

a. Turn on the system in accordance with paragraph 3.4.

b. Turn on the desired plug-in unit in accordance with paragraph 3.6.

c. Check that the PRESET SWEEP light is not on for the selected plug-in unit on its Model 9511 panel. Push the adjacent PRESET SWEEP button to obtain the "Off" condition if necessary.

d. Refer to paragraph 3.6 of the Model 650 Instruction Manual for detailed procedures covering single-frequency operation, including choice of control and frequency selection. Refer to paragraphs 3.9 through 3.11 of the Model 650 manual for information about modulation provisions.

e. Make power level adjustments and leveling connections or control settings at the panel of the selected plug-in unit, following the procedure given in paragraph 3.12 of the Model 650 Instruction Manual for the leveling and power control mode desired.

f. If single-frequency output is desired from another plug-in unit, select that unit in accordance with paragraph 3.6.3 above, and carry out steps c through e above as necessary for the newly-selected unit. Note that if a single frequency from each of several bands needs to be selected quickly, a different one of the SINGLE Frequency controls on the Model 650 may be preset to the proper frequency for each unit, or the procedure of paragraph 3.11 may be used.

3.11 OPERATING PROCEDURE FOR SINGLE-FREQUENCY OR MANUAL SWEEP OUTPUT CONTROLLED FROM THE MODEL 9511 CONTAINING THE SELECTED PLUG-IN UNIT.

a. Turn on the system in accordance with paragraph 3.4.

b. Turn on the desired plug-in unit in accordance with paragraph 3.6.

c. Turn the Model 650 FREQUENCY Mode Selector switch to SWEEP $F_1 \rightarrow F_2$.

d. On the Model 9511 containing the selected plug-in unit, turn the PRESET SWEEP on for that unit by pushing the PRESET SWEEP button in to the "On" position. Also turn the PRESET SWEEP-STOP control for the selected plug-in unit fully CCW to the 0 position.

e. Use the PRESET SWEEP-START control on the Model 9511 panel for the selected plug-in unit to set the desired frequency anywhere in the band. This frequency may be swept manually or re-adjusted to a different frequency by turning the PRESET SWEEP-START control at any time. The 0 to 100 panel markings on this control correspond to the scale divisions on the frequency dial plate "logging" scale, and can be converted to frequency by visually correlating the logging scale with the frequency scale for the band in use.

f. Make power level adjustments and leveling connections or control settings at the panel of the selected plug-in unit, following the procedure given in paragraph 3.12 of the Model 650 Instruction Manual for the leveling and power control mode desired.

g. Refer to paragraphs 3.9 through 3.11 of the Model 650 manual for information about modulation provisions.

h. If single-frequency output is desired from another plug-in unit, select that unit in accordance with paragraph 3.6.3 above, and carry out steps d thru f above as necessary for the newly-selected unit. Note that if a single frequency from each of several bands needs to be selected quickly, the PRESET SWEEP controls for each unit can be set up before turn-on.

3.12 PROCEDURE FOR SYSTEM TURN-OFF.

To turn off the system, turn the Model 650 POWER switch off. This removes power from all units. Since the selection of PRESET SWEEP and PLUG-IN STANDBY modes is controlled by mechanical switching through the push on - push off type switches on each Model 9511 panel, the established conditions at the time of system shut down will be restored when power is again turned on, unless the push buttons are operated while power is off.

The plug-in selection switching is electronic, and drops out when power is turned off. A new selection must be made in accordance with paragraph 3.6 when power is again turned on.

3.13 PROCEDURE FOR INSTALLATION OR REMOVAL OF PLUG-IN UNITS.

Turn system power off using the Model 650 POWER switch, and wait 15 seconds (see CAUTION notice following paragraph 3.4). Then follow the procedure of paragraph 2.5.

Table 4-1. Printed Circuit Boards in the Model 9510/9511 System

Location	PC Board Module No.	PC Board Name and Assy No.	Description
Model 9510	A1	Selector PC Board Assy 951705	Provides the switching and lock-in "memory" function to activate the control circuit for the selected plug-in unit and de-activate the previously-energized unit. A1 serves all left-hand plug-in units with a separate, identical switch/memory circuit for each.
Model 9510	A2	Selector PC Board Assy 951705	Same as A1 above, except A2 serves all right-hand plug-in units with a separate, identical switch/memory circuit for each.
Model 9510	A3	Control PC Board Assy 951706	Contains circuitry for several independent functions used in switching and turn-on of individual plug-in units: a. A switching pulse circuit which develops a signal that allows actuation of a selection button to select one plug-in unit and drop out all others, and prevent multiple selection. b. Regulator circuitry for the - 8 V developed for use in the Model 9510. c. Clamp circuitry that keeps the cathode and anode voltage low during the switching interval to prevent application of high voltage transients to BWO tubes. d. Control circuitry that operates the above clamp circuits to apply high voltage at the time the rf output should be obtained, in accordance with the standby mode of the particular unit selected.
Model 9510	A4	Preset Sweep PC Board Assy 951704	Develops a ramp or a fixed dc output anywhere within the range of 0 to +15 V for swept or single-frequency control of the Model 650 in response to the two 0 to - 15 V signals obtained from the F_1 and F_2 PRESET SWEEP controls for the selected plug-in unit, when that unit is in the PRESET SWEEP mode.
Model 9511	A1	High Voltage Control PC Board Assy 951694	Develops control signals to energize the switching relays to activate the selected plug-in unit (when it is located in the same Model 9511) and controls turn-on delay when the selected unit is in Standby Off mode.
	A2	Relay PC Board Ass 951697	In response to control signal from PC Board A1 in the same Model 9511, energizes the appropriate relays to activate the selected plug-in unit.

SECTION IV

THEORY OF OPERATION

4.1 GENERAL.

4.1.1 INSTRUMENTATION FUNCTION. The Model 9510 and 9511 contain the circuitry necessary to perform the following functions:

a. Apply all necessary BWO operating voltages from the Model 650 to the plug-in unit selected for operation.

b. Provide Standby On or Standby Off modes independently for each plug-in unit.

c. Permit selection of any plug-in unit at any time with automatic cancellation of the previously selected unit and with positive means for preventing selection of more than one unit simultaneously.

d. Provide different turn-on speeds depending upon whether the selected unit is in Standby On mode (<1 second turn-on) or in Standby Off mode ($\approx$ 90 second turn-on) or was placed in Standby On mode <90 seconds before selection (turn-on occurs when the 90 second standby period is completed), and control the application of high voltage differently for each mode, as a means of gating off the BWO until the proper turn-on time.

e. Provide a separate heater supply and grid bias supply in each Model 9511 to permit independent control of standby heater power and to allow grid-bias cut-off of all tubes except the one selected for rf output, without loading the Model 650.

f. Prevent turn-on of a unit that is not properly plugged in.

g. Permit selection of the Preset Sweep mode to over-ride the Model 650 controls, and develop a suitable drive signal from the settings of the PRESET SWEEP controls for the selected plug-in unit.

4.1.2 CIRCUIT MODULES. In order to accomplish the above functions, the switching and selection circuitry having interface with all plug-in units is contained in the Model 9510, and the circuitry which responds to selection signals and controls operation of each pair of plug-in units is contained in the Model 9511. The functions of major PC boards are listed in Table 4-1.

4.2 BWO OPERATING VOLTAGE SWITCHING AND CONNECTION TO PLUG-IN UNITS (See Figures 4-1 and 4-2).

4.2.1 HIGH VOLTAGE DISTRIBUTION TO ALL MODEL 9511's. High voltage from the Model 650 is normally made available to plug-in units at connector J7 which mates with P7 on the plug-in unit. In this system, mating connector P7 in the Model 9510 accepts these high voltages and connects them directly to J5 as shown in Schematic D907319. From there, these voltages are distributed in parallel to all Model 9511's via the J5/P6 interconnections, as shown in Figure 4-1 and Schematic D907321.

4.2.2 HIGH VOLTAGE CONNECTIONS TO PLUG-IN UNITS (See Figure 4-1). To eliminate switching high voltage, the cathode/htr (+),/0 line supply voltage is always connected directly to P7 of all plug-in units via J3 and J4 in each Model 9511. All other BWO operating voltages are switched, by means of relays, so that they are applied only to the plug-in unit selected for use, as shown in Figure 4-1. The relays used in each Model 9511 are K7 and K9 for the left-hand plug-in unit and K8 and K10 for the right-hand plug-in unit.

When a BWO is selected for operation, relays also connect the diode shaper board (cathode) and anode feedback circuits from the selected plug-in unit to the Model 650, thereby controlling the corresponding supplies to provide correct voltages for the selected BWO.

The upper Form C contact of K9 or K10 ties each BWO anode to its respective cathode on every plug-in unit except the one selected for use. This, in addition to the grid cut-off bias applied to every plug-in unit (see par. 4.5.1) except the one selected for use, assures that only the one BWO selected is actually operating. Thus, BWO's are protected against being operated with incorrect cathode voltage (because no BWO electron current is permitted when the tube is driven by a cathode voltage pertaining to another (BWO) and BWO's are also protected against having excessive anode voltage applied (because the anode is clamped to the cathode by K9 or K10 except when the BWO is to be operated). In addition, both the anode and cathode (diode shaper) feedback lines are "clamped" (with Control PCB A3) in the Model 9510 to obtain the lowest possible supply voltages during each switching interval so that no overload can occur when switching from a plug-in unit requiring relatively high voltages to one requiring relatively low voltages.

4.3 LOW VOLTAGE SUPPLY, SIGNAL, AND FEEDBACK SWITCHING AND CONNECTION TO PLUG-IN UNITS (See Figure 4-2).

4.3.1 LOW VOLTAGE CIRCUIT DISTRIBUTION TO ALL MODEL 9511's. Low voltages, control signals, and feedback interconnections between the Model 650 and plug-in units are normally made through J6 which mates with P6 on the plug-in unit. In this system, mating connector P6 in the Model 9510 accepts these signals and connects them directly to J5, as shown in Schematic D907319. From there, these voltages are distributed in parallel to all Model 9511's via the J5/P6 interconnections, as shown in Figure 4-2 and Schematic D907321.

4.3.2 LOW VOLTAGE CONNECTIONS TO PLUG-IN UNITS. To eliminate loading of supply and control signals from the 650, and to prevent applying erroneous signals to feedback circuits within the Model 650, all these connections are made through relay contacts, as shown in Figure 4-3, so that the circuits are connected only to the plug-in unit selected for use. The relays used in each Model 9511 are K1, K3, and K5 for the left-hand plug-in unit and K2, K4 and K6 for the right-hand plug-in unit. Only the ground reference connection and the high voltage trip test signal

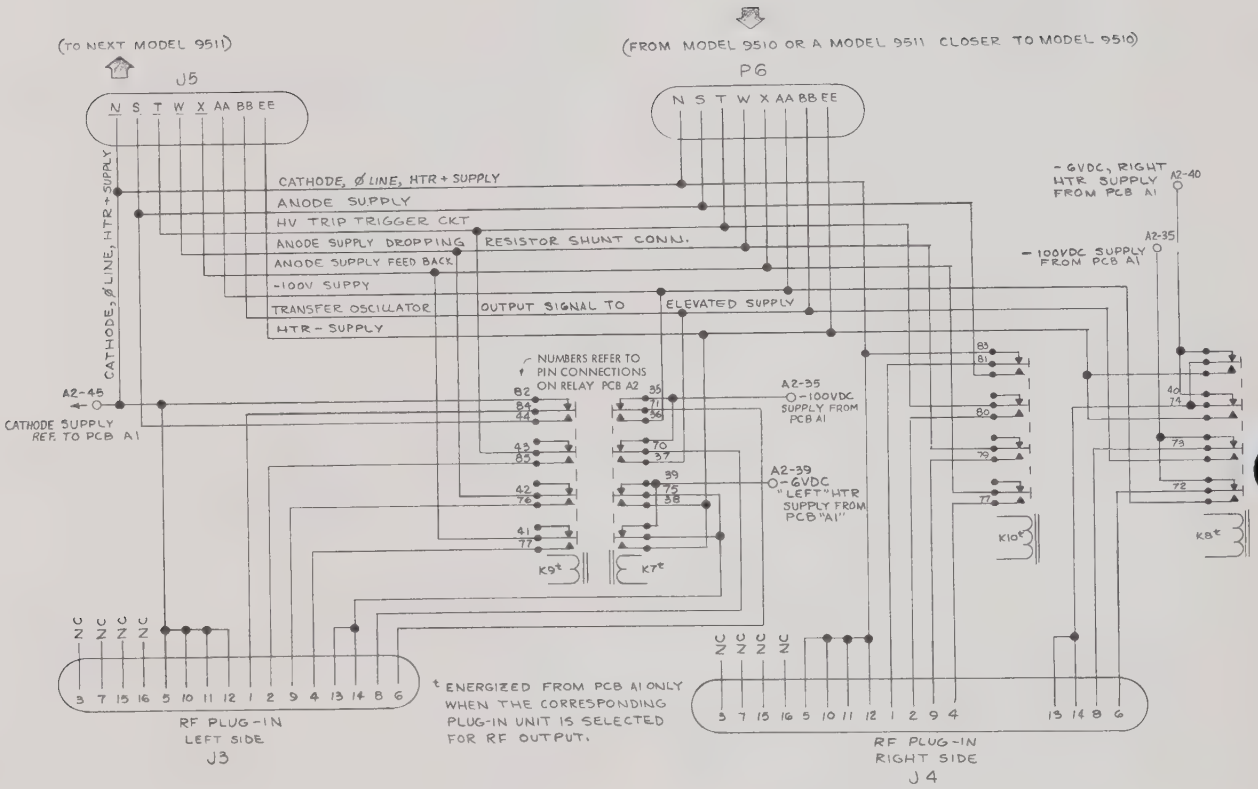

(TO NEXT MODEL 9511)
J5
N S T W X AA BB EE
(FROM MODEL 9510 OR A MODEL 9511 CLOSER TO MODEL 9510)
P6
N S T W X AA BB EE
CATHODE, Ø LINE, HTR + SUPPLY
CATHODE, Ø LINE, HTR + SUPPLY
ANODE SUPPLY
HV TRIP TRIGGER CKT
ANODE SUPPLY DROPPING
RESISTOR SHUNT CONN.
ANODE SUPPLY FEED BACK
-100V SUPPY
TRANSFER OSCILLATOR
OUTPUT SIGNAL TO
ELEVATED SUPPLY
HTR - SUPPLY
- 6VDC, RIGHT HTR SUPPLY FROM PCB A1
A2-40
A2-35
- 100VDC SUPPLY FROM PCB A1
NUMBERS REFER TO PIN CONNECTIONS ON RELAY PCB A2
A2-45
CATHODE SUPPLY REF. TO PCB A1
A2-35
-100VDC SUPPLY FROM PCB A1
A2-39
-6VDC "LEFT" HTR SUPPLY FROM PCB "A1"
K9†
K7†
K10†
K8†
3 7 15 16 5 10 11 12 1 2 9 4 13 14 8 6
RF PLUG-IN LEFT SIDE
J3
† ENERGIZED FROM PCB A1 ONLY WHEN THE CORRESPONDING PLUG-IN UNIT IS SELECTED FOR RF OUTPUT.
3 7 15 16 5 10 11 12 1 2 9 4 13 14 8 6
RF PLUG-IN RIGHT SIDE
J4

FIGURE 4-1. SIMPLIFIED SCHEMATIC DIAGRAM OF HIGH VOLTAGE SWITCHING AND INTERCONNECTIONS IN MODEL 9511.

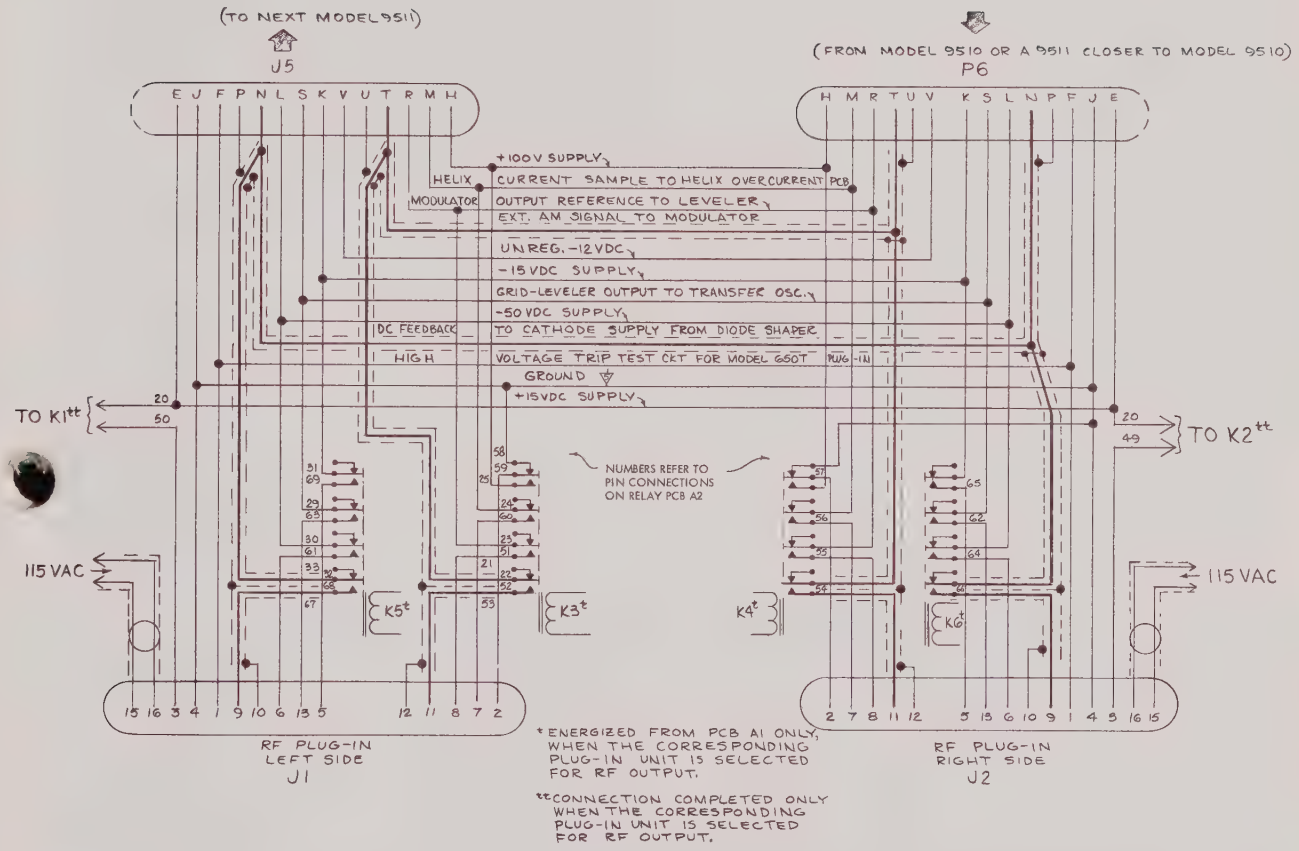

(TO NEXT MODEL 9511)
J5
(FROM MODEL 9510 OR A 9511 CLOSER TO MODEL 9510)
P6
E J F P N L S K V U T R M H
H M R T U V K S L N P F J E
+100V SUPPLY
HELIX
CURRENT SAMPLE TO HELIX OVERCURRENT PCB
MODULATOR
OUTPUT REFERENCE TO LEVELER
EXT. AM SIGNAL TO MODULATOR
UNREG. -12VDC
-15VDC SUPPLY
GRID-LEVELER OUTPUT TO TRANSFER OSC.
-50VDC SUPPLY
DC FEEDBACK
TO CATHODE SUPPLY FROM DIODE SHAPER
HIGH
VOLTAGE TRIP TEST CKT FOR MODEL 650T
PLUG-IN
GROUND
+15VDC SUPPLY
TO K1tt
20
50
TO K2tt
20
49
115 VAC
115 VAC
NUMBERS REFER TO PIN CONNECTIONS ON RELAY PCB A2
K5t
K3t
K4t
K6t
15 16 3 4 1 9 10 6 13 5
12 11 8 7 2
2 7 8 11 12
3 13 6 10 9 1 4 5 16 15
RF PLUG-IN LEFT SIDE
J1
RF PLUG-IN RIGHT SIDE
J2
*ENERGIZED FROM PCB A1 ONLY, WHEN THE CORRESPONDING PLUG-IN UNIT IS SELECTED FOR RF OUTPUT.
**CONNECTION COMPLETED ONLY WHEN THE CORRESPONDING PLUG-IN UNIT IS SELECTED FOR RF OUTPUT.

FIGURE 4-2. SIMPLIFIED SCHEMATIC OF LOW VOLTAGE SWITCHING AND INTERCONNECTIONS IN MODEL 9511.

circuit connection (which is used only with Model 650 T and 650 and 650 P Plug-in units) are direct-connected to each plug-in unit without relays. The upper Form C contact of K3 or K4 ties the plug-in unit +100 V supply line to ground for every plug-in unit except the one selected for use. This assures that no voltage is available to operate the UNLEVELED light on unused plug-in units, and also terminates the collector on BWO tubes which have that electrode.

4.4 SELECTION AND TURN-ON OF PLUG-IN UNITS. (See Figures 4-3 and 4-4).

4.4.1 GENERAL. A momentary ground connection provided when a Select push button on the Model 9510 is pressed - or by a remote contact - actuates the Control PC board A3 in the Model 9510 to clear the previous selection and lock in the new selection in the appropriate Selector PC board A1 or A2. The Selector PC boards generate the operating signals for the Model 9511 to de-energize the relays which made low-voltage and high voltage connections to the previously used unit and energize the relays to make connections to the newly selected unit. If the selected unit is not in Standby On mode, the high voltages are clamped to a safe low value for 90 seconds by the Model 9510 Control PC board, in response to a non-standby signal from the Model 9511 High Voltage Control PC board.

4.4.2 OPERATION OF SELECTION SWITCHING & LOCK-IN CIRCUITS IN MODEL 9510 SELECTOR PC BOARDS A1 AND A2 (See Figure 4-3). There is an individual selector switching/lock-in memory circuit for each channel, having the configuration shown in Figure 4-3. The five left-hand selector circuits are contained on Selector PC board A1 and the five right-hand selector circuits are contained on Selector PC board A2. Only one typical circuit is described in the discussion below, as shown in Figure 4-3. The complete circuit board schematic, D907316, is included at the rear of this manual.

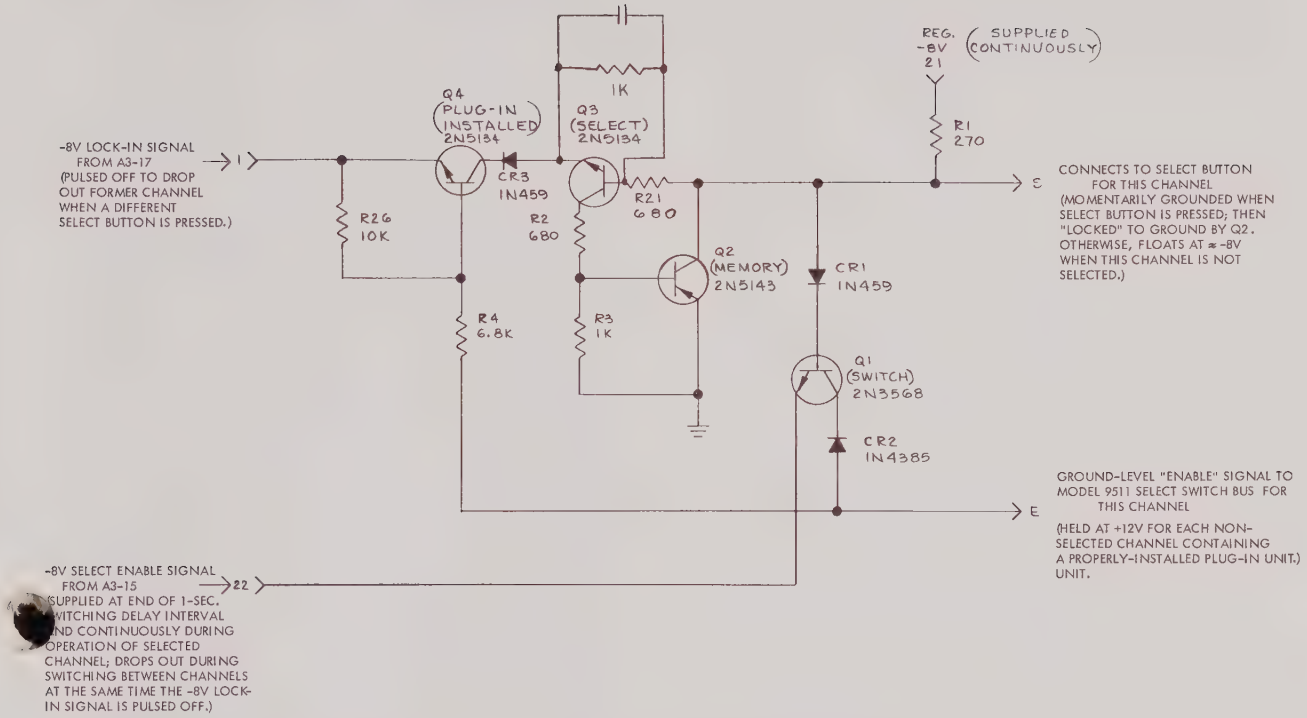
4.4.2.1 Operation When Power is First Applied to System. When power is first applied to the system before any Select button is pressed, switch transistor A1Q1 is cut off in each circuit by the -8 V applied to its base through A1R1 and A1CR1, so that no Model 9511 receives a turn-on enable signal. On every selector circuit for which a corresponding plug-in unit is properly installed and the interlock switch in the Model 9511 is actuated, +12 V is applied to terminal E from the +12V supply in the Model 9511. This +12V is the relay return voltage which energizes the Model 9511 selection relays for the selected plug-in unit when the 9510 switch transistor A1Q1 is turned on to complete the circuit to ground. The +12V appears on the terminal "E" line whenever the plug-in is connected and terminal "E" is not switched to ground. The +12V at terminal E turns on transistor A1Q4 which indicates "plug-in installed". When this transistor is on, the selector circuit itself is "enabled" to respond to a ground signal at terminal "S" when a selector button is pressed.. If A1Q4 is not on, indicating "improper installation or "no installation" of a plug-in unit in the corresponding Model 9511 position, the selector circuit for that unit is disabled. This makes it impossible to select that Model 9511 position.

4.4.2.2 Operation When the First Select Pushbutton is Pressed. When the first Select button is pressed, terminal "S" on only the selector circuit for the corresponding channel is momentarily grounded through terminals 5-6 on the particular button (S1-S10) pressed. If transistor A1Q4 is turned on, indicating that the plug-in unit is properly installed, an emitter return path is provided for "select" transistor A1Q3 and it turns on to saturation, since its base is raised to ground level via terminal S. The R-C network across the emitter/base connections to A1Q3 provides a slight turn-on delay to provide impulse noise immunity. Collector current through A1Q3 provides a V_{eb} bias drop for "memory" transistor A1Q2, turning it on to saturation. The collector of A1Q2 then holds terminal "S" close to ground and "locks in" the selector circuit for the selected channel. Simultaneously, the "switch" transistor A1Q1 is turned on to saturation by the ground-level base bias applied from the terminal "S" line. This effectively grounds terminal E, and energizes K1, K3, and K5 (left-hand unit) or K2, K4, K6 (right-hand unit) in the Model 9511 for the selected plug-in unit, and initiates turn-on of that unit.

4.4.2.3 Operation When the Next Select Pushbutton is Pressed. When the next Select pushbutton is pressed, the interlock circuitry on the Control PC board comes into play. Actuation of the next Select push button momentarily grounds terminal "S" in another Selector Circuit, corresponding to that button, while A1Q2 in the board previously locked-in continues to hold its terminal "S" at ground. To prevent two channels from being energized simultaneously, the Control PC board, in response to "ground level" signals from more than one channel, interrupts the -7V applied to terminal 1 and the -8V applied to terminal 22 of every Selector PC board. This drops out the previously selected channel by turning off A1Q1, and "unlocks" the memory transistor A1Q2 in that channel by turning off A1Q4, which cuts off A1Q3 and A1Q2. When A1Q2 is cut off in the previously selected channel, it no longer clamps terminal S of that channel to ground, and -8V is then re-applied to that terminal "S" via A1R1 to keep A1Q1, A1Q2, and A1Q3 cut off.

The above events occur instantaneously when the next select pushbutton is pressed, dropping out the old channel well before the operator's finger has been removed from the button. Once the old channel is dropped out, the Control PC board receives only one ground level signal, from terminal "S" of the new channel (since the operator's finger is still holding the button in). The Control PC board then restores -7 V to terminal 1 instantly. This turns on the "plug-in installed" transistor (Q4) in the new selector channel if its plug-in unit is properly installed. Then the "select" and "memory" transistors (Q3 and Q2) turn on in the new selector circuit (as described in par. 4.4.2.2).One second later, -8 V is restored to terminal 22 to enable turn-on of the "switch" transistor which grounds terminal E, providing the "enable" signal to energize the new channel.

4.4.2.4 Operation When Two or More Select Pushbuttons are Pressed or Held in. In this case, the Control PC board responds to a ground level signal from the "S" Terminal of two or more channels by removing -7 V from terminal 1 and -8 V from terminal 22. This drops out any channel already in operation


REG. -8V 21
SUPPLIED CONTINUOUSLY
1K
Q4 (PLUG-IN INSTALLED) 2N5134
Q3 (SELECT) 2N5134
R1 270
-8V LOCK-IN SIGNAL FROM A3-17
(PULSED OFF TO DROP OUT FORMER CHANNEL WHEN A DIFFERENT SELECT BUTTON IS PRESSED.)
1
CR3 IN459
R21 680
R26 10K
R2 680
Q2 (MEMORY) 2N5143
CR1 IN459
R4 6.8K
R3 1K
Q1 (SWITCH) 2N3568
CR2 IN4385
S
CONNECTS TO SELECT BUTTON FOR THIS CHANNEL (MOMENTARILY GROUNDED WHEN SELECT BUTTON IS PRESSED; THEN "LOCKED" TO GROUND BY Q2. OTHERWISE, FLOATS AT ≈ -8V WHEN THIS CHANNEL IS NOT SELECTED.)
E
GROUND-LEVEL "ENABLE" SIGNAL TO MODEL 9511 SELECT SWITCH BUS FOR THIS CHANNEL
(HELD AT +12V FOR EACH NON-SELECTED CHANNEL CONTAINING A PROPERLY-INSTALLED PLUG-IN UNIT.)
UNIT.
-8V SELECT ENABLE SIGNAL FROM A3-15
22
SUPPLIED AT END OF 1-SEC. SWITCHING DELAY INTERVAL AND CONTINUOUSLY DURING OPERATION OF SELECTED CHANNEL; DROPS OUT DURING SWITCHING BETWEEN CHANNELS AT THE SAME TIME THE -8V LOCK-IN SIGNAL IS PULSED OFF.)

NOTE: TERMINALS "S" AND "E" ARE USED TO DENOTE THE SELECT INPUT AND ENABLE OUTPUT SIGNAL TERMINALS WHICH ARE DIFFERENT FOR EACH INDIVIDUAL CIRCUIT. CIRCUIT REFERENCE DESIGNATORS DIFFER FOR EACH INDIVIDUAL CIRCUIT, AND THOSE USED ARE TYPICAL. REFER TO SCHEMATIC D907316 FOR THE PROPER REFERENCE DESIGNATORS FOR EACH INDIVIDUAL CIRCUIT.

FIGURE 4-3. SIMPLIFIED SCHEMATIC DIAGRAM OF TYPICAL CHANNEL SELECTOR CIRCUIT IN MODEL 9510 SELECTOR PC BOARD A1 OR A2.

and prevents selection of any new channel until the multiple buttons are released. The channel corresponding to the last button released is selected in accordance with par. 4.4.2.3.

4.4.3 OPERATION OF SELECTION CONTROL CIRCUITS IN MODEL 9510 CONTROL PC BOARD A3 (See Schematic D907-318). Diff. amp A3Q28/A3Q2 triggers operation of the selection control circuits on this board. When power is applied to the system and when only one pushbutton has been pressed or when the first channel is operating, A3Q2 is conducting and A3Q28 is cut off. This is because the base of A3Q2 is held at -3.4 V by divider A3R16/A3R17, while the base of A3Q28 is returned to a lower voltage: either -8V via A3R11 and R12 when power is on with no channel selected or ≈-4V when one channel is selected or operating. [Terminals 19-28 connect to the "S" terminal of the corresponding selector circuits and thereby are individually grounded when a select button is pressed or a selected channel is in operation. A3R11, which returns to -8V through the base-emitter drop of A3Q1, is equal in value to the resistor in the grounded line (A3R1 - A3R10), which returns to ground through the diode drop in A3CR1 - A3CR10.] When more than one select button is pressed, or one button is pressed to change channels with one in operation, at least two of the terminals 19-28 are simultaneously grounded, dividing the drop from ground to the A3Q28 base through two resistors A3R1 - A3R10. This raises the A3Q28 base voltage to ≈-2 V, to saturate A3Q28 and cut off A3Q2. This cut-off of A3Q2 lasts until just one of the terminals 19-28 supplies a ground signal (i.e. until the previous channel is dropped out or until multiple buttons are released to allow a single-channel selection.) A3Q1 insures that A3Q2 is cut-off (no emitter current) when no channel is selected.

4.4.3.1 Interruption of -8V "Lock-In" Signal At A3-17. The short duration cut-off of A3Q2 is used to generate system switching signals required for proper operation of the Selector PC boards as described in paragraph 4.4.2. The cut-off of A3Q2 cuts off A3Q4 by raising its base to ground level. The cut-off of A3Q4 eliminates the base bias drop for A3Q9 across A3R18, thereby turning off A3Q9. This removes the -8 V selection lock-in signal from J3-17. Removal of -8 V from J3-17 drops out the previously selected channel in the Selector PC board and prevents selection of any other channels.

4.4.3.2 Interruption of -8V "Select Enable" Signal at A3-15. Before cut-off of A3Q4 and A3Q9, their conduction provides -8V emitter bias for A3Q5, which thereby is held at saturation, since its base is returned to ground through R21. Conduction of Q5 maintains its base voltage at ≈-7.4V. Conduction of Q5 also reduces the voltage drop across network A3R22 /R23 to a fraction of a volt, and the resulting negligible base-emitter bias applied to A3Q7 holds it cut off. With A3Q7 cut off, the + lead of A3C5 is near ground level since negligible current flows through A3R24 or A3R53, and A3Q7, A3Q8 and A3-Q26 are cut off in the quiescent non-switching periods. Since the - side of A3C5 is held at ≈-7.4 V by connection to the base of A3Q5, there is a charge of ≈6.2 V on A3C5 before cut-off of A3Q4.

When A3Q4 cuts off, it cuts off A3Q5 by cutting off A3Q9 (which removes the A3Q5 emitter voltage). Capacitor A3C5 then starts discharging through A3R21. When A3Q5 cuts off, its collector voltage rises toward ground level and turns on A3Q7. Turn-on of A3Q7 feeds electron current from -8 V to ground through A3R24 and the base-emitter junction of A3-Q26 and A3Q8. This forward-biases both A3Q26 and A3Q8, turning them on.

Turn-on of A3Q26 raises its collector to a voltage more postive than -1.2 V, thereby cutting off A3Q27. This removes the base bias from A3Q6, cutting it off. Cutoff of A3Q6 disconnects J3-15 from the -8 V bus, disabling the Selector PC boards to prevent turn-on of any channel. This assures that the old channel is dropped out and provides redundant protection against turn-on of multiple channels during the switching interval, and for one second after the desired channel alone is ready to lock in. This 1 second delay is provided by the discharging and recharging of A3C5.

4.4.3.3 Restoration of -8V "Lock-in" Signal as Switching Takes Place. When the old channel has dropped out and only 1 select button is depressed, the one ground connection provided through A3R1 - A3R10 is insufficient to hold A3Q28 turned on, and the direct-coupled stages immediately resume their quiescent state with A3Q2 and A3Q4 conducting and A3Q28 cut off. Turn-on of A3Q4 causes its collector voltage to jump toward ground. This instantly turns on A3Q9 to restore -8 V to J3-17, enabling the "memory" transistor in the selector circuit for the selected channel to turn on and lock in.

4.4.3.4 Restoration of -8 V "Select Enable" Signal 1 Second After "Lock-In" Signal. When A3Q9 turns on, as described above, it provides emitter voltage to A3Q5, allowing A3Q5 to turn on. This removes the base bias from A3Q7 and cuts it off. A3Q5 saturates at turn-on, holding its base at ≈-7.2 V. This restores a voltage gradient across A3C5 to charge it. Since A3C5 has been discharged, it feeds electron current to ground through A3R24 and the bases of A3Q8 and A3Q26 while charging, keeping these transistors turned on during the charging interval, even though A3Q7 has been cut off by its back-biased base.

After 1-second switching delay provided by the discharging and charging of A3C5, its (+) terminal rises above -1.2V and cuts off A3Q26 and A3Q8. This unclamps the base of A3Q27, allowing that transistor to turn on and forward-bias A3Q6 to saturation. A3Q6 then couples -8V to J3-15, enabling the switching transistor of the appropriate Selector PC board to energize the selected channel.

4.4.4 OPERATION OF HIGH VOLTAGE CLAMP CIRCUITS IN MODEL 9510 CONTROL PC BOARD A3 (See Schematic D907318). These circuits are triggered whenever a channel is de-energized, and at the start of each switching interval, to clamp the BWO cathode and anode voltages until a channel is energized as described in paragraph 4.4.2, and with additional turn-on delay if the selected plug-in unit is not in the Standby On mode. These circuits allow voltages developed for the previously-selected channel to decay and also prevent rf turn-on without proper warm-up.

4.4.4.1 Generation of Clamp Control Voltage. There are three different conditions when voltages are to be clamped: (a) For 1 second during switching, if the selected plug-in unit has been in Standby On mode for a full 90 seconds or more; (b) For 1 second during switching + 90 seconds additional, during the required warmup cycle, if the selected plug-in unit is in Standby Off mode; (c) For 1 second during switching + less than 90 seconds additional, to permit completion of a 90-second warmup cycle, if the selected unit was switched to Standby On mode less than 90 seconds before it was selected for rf output.

In each case, the voltage clamping is controlled by the signal developed at the common connection between the collector of A3Q8 and A3Q10 and the bases of A3Q18 and A3Q20. When the cathode and anode voltages are to be clamped, this common point is held near ground level by turn-on of A3Q8 or A3Q10. When the voltages are to be unclamped, this common point is allowed to rise to about +2.5 V, through voltage drops across A3R43, A3Q20, A3Q24, A3CR15, and A3CR21, when both A3Q8 and A3Q10 are cut off.

For condition a, the clamp control is provided by A3Q8 alone, which turns on for 1 second during switching as described in paragraphs 4.4.3.2 and 4.4.3.4. A ground-level signal applied to A3-8 from the Model 9511 keeps A3Q10 cut off.

For condition b, the Model 9511 provides a +12V signal via P6-W to A3-8, indicating that the selected unit is in Standby Off mode. This turns on A3Q10 to keep the voltages clamped, and activates the warm-up timer circuit, A3Q12 - A3Q17 in the Model 9510. This timer circuit removes the (+) bias to cut off A3Q10 after 90 seconds, unclamping the high voltages.

For condition c, the Model 9511 allows A3-8 to float, and this allows positive drive to be supplied to A3Q10 from the +15 V bus to turn it on for the remaining portion of the warm-up period, after which it is cut-off by a ground level signal which is applied to A3-8 from the Model 9511 at the completion of its 90-second warm-up interval.

Detailed operation of the timer circuit A3Q12 - A3Q17 for condition b is described in paragraph 4.4.4.4; for condition c, timer holdoff is described in paragraph 4.4.4.5.

4.4.4.2 Clamping Cathode Supply Voltage to -50 V During Switching and Non-Standby Warm-up. In normal operation, the cathode supply adjusts itself to an output voltage which produces low voltage (-) dc feedback through the diode shaper board to balance the (+) frequency control signal from the panel controls and/or sweep ramp. During the 1-second switching interval and the non-standby turn-on delay period (if any), the cathode supply is clamped to -50 V by the action of A3Q18, A3Q19 and A3CR17.

When the instrument is first turned on, and during the quiescent period after any selected plug-in unit is warmed up and operating, the A3Q18 base is held at +15 V through A3R43, keeping it cut off. When switching between channels occurs, turn-on of A3Q8 (and A3Q10 as applicable), drops the A3Q18 base to ground level, turning it on to saturation, since its emitter is held at ≈+1.2 V by A3CR15 and A3CR21. The resultant current through A3R41 forward-biases A3Q19 to saturation. This clamps the Model 650 cathode supply dc feedback line (normally driven only by the diode shaper board of the selected plug-in unit) to -20V supplied by A3VR5 from the -50V supply. This causes the cathode supply output voltage to drop in an attempt to "reduce" this -20V "feedback", in its normal closed-loop response mode. To prevent this open-loop -20 V drive from driving the voltage to ground or slightly positive, A3CR17 is connected between the cathode supply line (A3-1) and the -50 V supply (A3-5). Since the -50 V supply is ground-referenced, this diode prevents the cathode supply from going more positive than -50 V below ground, clamping it at this harmless level during the switching intervals.

At the completion of the switching interval, A3Q8 turns off to enable the selected channel. If the selected channel has been in the Standby On mode for >90 seconds, A3Q10 will be cut off, and A3Q19 will cut off when the turn-off of A3Q8 removes its ground-level base bias. Otherwise, A13Q19 will cut off when A3Q10 is cut off at the end of the warm-up period. (90 seconds or less).

When A3Q19 is cut off to unclamp the cathode supply, the cathode voltage is controlled by feedback from the diode shaper board in the selected plug-in unit, which was switched into the feedback circuit during the clamped interval.

4.4.4.3 Clamping Anode Supply Voltage to the Cathode (-50 V) During Switching and Non-Standby Warm-up. In normal operation, the anode supply is regulated at a fixed positive voltage with respect to the cathode, as required by each individual BWO tube, controlled by a feedback loop in each plug-in unit through a factory - selected feedback resistor. The feedback circuit is set up to provide a feedback level between that of cathode voltage and the -100 V supply (which is 100 V below cathode), for comparison with a reference voltage developed between the same voltages within the anode supply in the Model 650. During the 1-second switching interval and the "standby" turn-on delay period (if any), the anode supply is clamped to ≈+20 V with respect to the cathode voltage level (which itself is clamped to -50 V). This is done by clamping the anode supply feedback line to cathode voltage by turn-on of A3Q23, which unbalances the anode supply regulator amplifier in the Model 650 so that negative grid bias is removed from anode regulator tube V4 (in the Model 650). This causes V4, connected between the anode and cathode supply lines, to conduct heavily, limiting the anode voltage to a few volts above cathode level.

The anode clamp circuit is controlled by A3Q20, which responds to the same signals as the cathode clamp circuit described in paragraph 4.4.4.1, but in complementary fashion. The base of A3Q20 is connected to the base of A3Q18. Since A3Q20 is NPN, it will be on during normal operation due to the +15 V supply connection provided through A3R43. It will be cut off during the 1-second switching interval and the non-standby warm-up period (if any), when its base is held at ground level as described in paragraph 4.4.4.1.

During normal operation, outside switching and warm-up periods, when A3Q20 is on, it energizes DS1 which illuminates photo-transistor A3Q21. Under that condition, A3Q21 coupled the base of A3Q22 to a level established by A3VR4, 6.2 V below cathode supply voltage. This forward-biases A3Q22 to saturation, since its emitter is tied directly to the cathode supply. Turn-on of A3Q22 clamps the base of A3Q23 to cathode supply level, to which its emitter is also returned via A3CR16, cutting it off. This removes the clamp between A3-1 and A3-2, allowing the anode feedback line to be controlled in the normal manner from the plug-in unit.

During switching and warm-up, when A3Q20 is cut off, A3Q21 offers high resistance and A3Q22 is biased to cutoff by A3R45. A3Q23 is then forward-biased to saturation through A3R47, which connects its base to -100 V below cathode, and clamps A3-1 to A3-2. A3CR23 eliminates any switching transients that might drive the anode supply feedback line positive with respect to cathode voltage.

4.4.4.4 Operation of Warm-up Interval Timer Circuit in Model 9510 When the Selected Plug-in Unit is in Standby Off Mode. In this situation, +12V is supplied to A3-8 when the Model 9511 relays operate to connect the selected unit. This bias, applied through A3R30, turns on A3Q10 to maintain hv clamping at the time A3Q8 cuts off. The interval timer circuit, A3Q11 - A3Q17 operates as follows to turn on A3Q11 after 90 seconds, thereby robbing base current from A3Q10 to cut it off and unclamp the high voltages:

When A3Q6 turns on to enable the relays, it applies -8V through A3CR22 and A3CR14 to the emitter of A3Q17. Relay operation for the selected unit in the Model 9511 applies +12 V to A3-8. Zener diode A3VR3 is connected between these two voltages, in series with A3R36 and the A3Q17 base. A3Q17 is thus forward-biased to saturation, coupling the base of A3Q13 to a negative voltage that turns it on to a saturation. Before turn-on of A3Q13, both sides of timing capacitor A3C6 were connected to ≈ -8V, the (-) side directly and the (+) side through A3R37 and A3R57, so that A3C6 is completely discharged. Saturation of A3Q13 raises the voltage at the junction of A3R37 and A3R57 to ≈ +15V, thereby initiating a charging interval in which A3C6 starts charging toward +15 V through A3R37. Timing resistor A3R37 is selected so that A3C6 will charge to the turn-on level of A3Q16 in 90 seconds.

The base of A3Q16 is biased at ≈-2 V by the action of voltage divider A3R32/A3R33 between -7.4 V and +15 V. Thus, when A3C6 charges up to ≈-1.4 V, it turns on A3Q16. This forward-biases A3Q15, since its emitter is returned to -7.2 V through A3R38 and A3R29. Saturation of A3Q15 couples ≈ -2 V to the base of A3Q12, forward-biasing it and A3Q14, also, to saturation. A3Q12 couples the bases of A3Q10 and A3Q11 to ≈-7 V through A3R27 and A3Q14, thereby cutting off A3Q10 (to unclamp the high voltages) and turning on A3-Q11 which keeps A3Q10 cut off, acting as a bi-stable flip-flop. Darlington pair A3Q12 and A3Q14 lock "on" through current flow from ground through their bases to -8 V via A3-Q11 and A3CR22. This holds A3Q11 on and A3Q10 off. Turn-on of A3Q14 shunts A3R39 to remove the forward bias from A3-Q17, cutting it off. This cuts off A3Q13 and allows A3C6 to discharge to -7.4 V through A3R37 and A3R57, cutting off A3-Q16 and A3Q15.

When another channel is selected, A3Q6 cuts off; removing the -8 V from A3CR22. This cuts off A3Q11, A3Q12, and A3Q14 and couples both sides of A3C6 to ground [(-) through A3R19 and (+) through A3CR13] . This resets the warm-up timer circuit to its original condition, quickly discharging A3C6 if it had not already had time to discharge. A3-8 floats during the switching interval, when all Model 9511 relays are de-activated. When switching is completed, the circuit will respond to the new signal applied to A3-8.

4.4.4.5 Operation of Warm-up Interval Timer Circuit in Model 9510 When the Selected Plug-in Unit has been in Standby On Mode Less Than 90 Seconds. In this situation, A3-8 remains floating after the switching interval is completed. Insufficient reverse bias is applied to zener diode A3VR3 to allow it to achieve breakdown. Therefore, A3Q17 remains cut off and the warm-up timer circuit is inactive. As long as A3-8 floats, A3Q10 is held on by the positive base bias applied from the +15 V bus (A3-6) through A3R31 and A3R30. This keeps the high voltages clamped. When the 90-second timer in the selected Model 9511 has cycled, it clamps A3-8 to ground, removing the A3Q10 positive base bias to cut it off and unclamp the high voltages.

4.4.5 OPERATION OF LAMP CONTROL CIRCUITS IN MODEL 9510 (See Schematic D907318). The Selection indicator lights receive negative drive voltage from A3-9, but only the one lamp corresponding to the selected unit has its return side grounded, to energize the light. The return side is grounded directly by the Select pushbutton when pressed, and then "locked" to ground by the memory transistor in the corresponding Selector PC board circuit, as described in paragraph 4.4.2, until the next selection is made. At that time, the former ground connection is interrupted and a new lamp is lighted.

Transistors A3Q24 and A3Q25 control the negative drive voltage applied to A3-9 to regulate the Selection indicator light intensity to be bright when rf output is provided (coincident with high voltage turn-on) and dim when the selected unit is warming up with hv clamped. A3Q24 is in series with A3Q20 so that they turn on together when high voltages are to be unclamped (for rf output), and are cut off when high voltages are clamped.

When A3Q24 is turned on to saturation, it forward-biases A3Q25 to saturate and shunt A3R52 to supply the full -8 V lamp drive to A3-9. When A3Q24 is cut off, A3Q25 is also biased to cutoff, and the lamp drive voltage is reduced by being applied through A3R52.

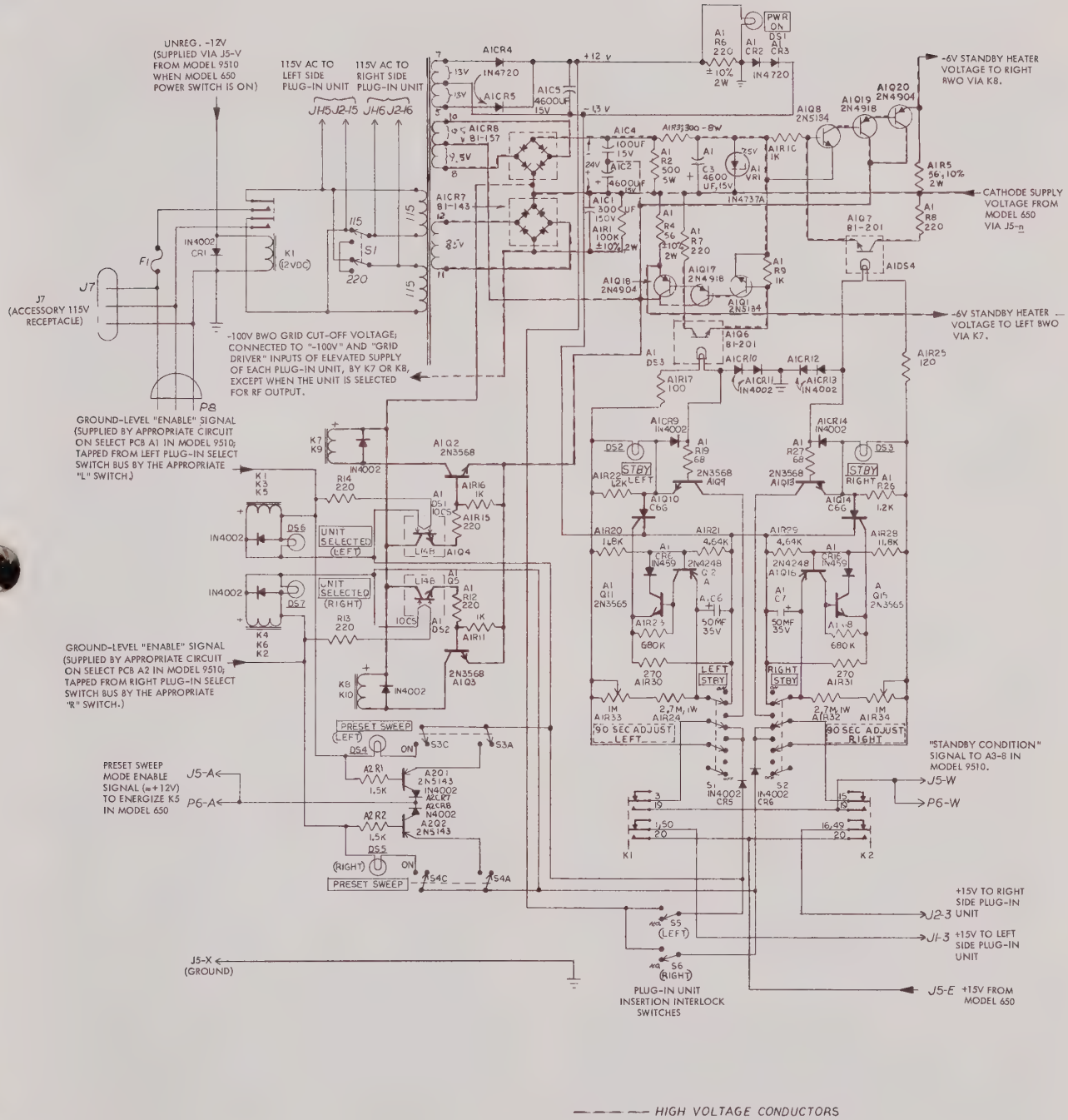

UNREG. -12V (SUPPLIED VIA J5-V FROM MODEL 9510 WHEN MODEL 650 POWER SWITCH IS ON)
115V AC TO LEFT SIDE PLUG-IN UNIT
115V AC TO RIGHT SIDE PLUG-IN UNIT
JH5 J2-15
JH6 J2-16
+12 V
-13 V
PWR ON DS1
-6V STANDBY HEATER VOLTAGE TO RIGHT BWO VIA K8.
-6V STANDBY HEATER VOLTAGE TO LEFT BWO VIA K7.
CATHODE SUPPLY VOLTAGE FROM MODEL 650 VIA J5-n
J7 (ACCESSORY 115V RECEPTACLE)
-100V BWO GRID CUT-OFF VOLTAGE; CONNECTED TO "-100V" AND "GRID DRIVER" INPUTS OF ELEVATED SUPPLY OF EACH PLUG-IN UNIT, BY K7 OR K8, EXCEPT WHEN THE UNIT IS SELECTED FOR RF OUTPUT.
GROUND-LEVEL "ENABLE" SIGNAL (SUPPLIED BY APPROPRIATE CIRCUIT ON SELECT PCB A1 IN MODEL 9510; TAPPED FROM LEFT PLUG-IN SELECT SWITCH BUS BY THE APPROPRIATE "L" SWITCH.)
GROUND-LEVEL "ENABLE" SIGNAL (SUPPLIED BY APPROPRIATE CIRCUIT ON SELECT PCB A2 IN MODEL 9510; TAPPED FROM RIGHT PLUG-IN SELECT SWITCH BUS BY THE APPROPRIATE "R" SWITCH.)
UNIT SELECTED (LEFT)
UNIT SELECTED (RIGHT)
PRESET SWEEP MODE ENABLE SIGNAL (=+12V) TO ENERGIZE K5 IN MODEL 650
PRESET SWEEP (LEFT)
PRESET SWEEP (RIGHT)
LEFT STBY
RIGHT STBY
90 SEC ADJUST LEFT
90 SEC ADJUST RIGHT
"STANDBY CONDITION" SIGNAL TO A3-B IN MODEL 9510.
+15V TO RIGHT SIDE PLUG-IN UNIT
+15V TO LEFT SIDE PLUG-IN UNIT
+15V FROM MODEL 650
PLUG-IN UNIT INSERTION INTERLOCK SWITCHES
J5-X (GROUND)
HIGH VOLTAGE CONDUCTORS

FIGURE 4-4. SIMPLIFIED SCHEMATIC DIAGRAM OF POWER SUPPLY AND CONTROL CIRCUITS IN MODEL 9511.

4.4.6 OPERATION OF RELAY CONTROL CIRCUITS IN MODEL 9511 TO ENERGIZE THE SELECTED PLUG-IN UNIT (See Figure 4-4). The relay control circuit for the selected unit responds to the ground level "enable" signal provided from point "E" in the Selector PC board circuit for that unit, developed as described in paragraph 4.4.2. It energizes the relays which connect all operating voltages to the selected plug-in unit.

4.4.6.1 Connection of "Enable" signal to the Selected Plug-in Unit. The selector circuit corresponding to each Select button applies its "Enable" signal to its individual "select" line from J5 in the Model 9510 to P6 of the first Model 9511. Within that Model 9511, the PLUG-IN SET-UP SELECTION switch for the same channel either connects the "enable" signal on to the next plug-in unit (down position) or connects it to the plug-in select bus for the right or left plug-in unit (up position). For example, when the L3 Select button is pressed on the Model 9510, the L3 selector circuit develops a ground-level enable pulse at J1-16, which is coupled to the first Model 9511 via J5-a and P6-a. If the L3 switch in the first Model 9511 is in the down position, the signal is coupled through to J5-a of that Model 9511 and to P6-a of the next Model 9511. If the L3 switch in the second Model 9511 is also in the down position, the signal is similarly coupled to the third Model 9511. If the L3 switch in the third Model 9511 is in the up position, the signal is coupled onto the plug-in select switch bus for the left-hand plug-in unit in that Model 9511, enabling it to turn on. Since the switch in the third Model 9511 in this example is in the up position, the signal is not routed on to more distant Model 9511's. This prevents actuation of multiple plug-in units by a single "enable" signal.

4.4.6.2 Activation of Relays to Turn On the Selected Plug-in Unit. (See Figure 4-4.) The ground-level "enable" signal is applied to the (-) side of the coils of relays K1, K3, and K5 (left-hand unit) or relays K2, K4, K6 (right-hand unit). The plug-in interlock switches S5 (left) or S6 (right) apply +12 V to the + terminal of the relay coils for properly-installed plug-in units, allowing the relays to pull in. The +12 V is supplied by full-wave rectifier A1CR4/A1CR5, which also drives the POWER ON light within the Model 9511. Operation of K3 and K5 (or K4 and K6) connects the low-voltage supply and feedback circuits to the selected plug-in unit instantly, as shown in Figure 4-1. Operation of K1 (or K2) supplies the proper standby condition signal to P6-W for connection to A3-8 in the Model 9510 to cause high voltage turn-on to be immediate (1 sec.) or delayed (up to 90 sec.) in accordance with the standby condition of the selected plug-in unit, as described in paragraph 4.4.4.1. The signal supplied to A3-8 controls only the clamping of the anode and cathode voltages. Actual connection of these and other high voltages to the selected plug-in unit is provided by K7 and K9 (or K8 and K10) as shown in Figure 4-2.

K7 and K9 (or K8 and K10) are energized by a 12 V supply floating at cathode potential, as shown in Figure 4-4, to avoid breakdown problems. The circuits operate as follows: The ground-level "enable" signal is also applied to lamp A1DS-1 (or A1DS-2). The lamp is returned to +12 V. The lamp lights after a short lamp warm-up delay which assures that low voltages are switched before high voltages are applied. It illuminates photo-transistor A1Q4 (or A1Q5), thereby dropping its resistance to allow turn-on of the high voltage relays K7 and K9 (K8 and K10). The phototransistor provides suitable isolation between the low voltage control signals and the high voltage relays. 12 V power for operation of these relays is supplied by one section of full-wave rectifier A1CR8, which develops 12 V across A1C2, with the (+) output tied to the cathode supply to which the (+) side of the K7 and K9 (or K8 and K10) coils are connected. Switch transistor A1Q2 (or A1Q3) is forward-biased by turn-on of A1Q4 (or A1Q5) to complete the return path from the (-) side of these relay coils to the (-) side of the supply (the junction of A1C2 and T1-9).

4.5 OPERATION OF MODEL 9511 GRID AND HEATER POWER SUPPLIES AND CONTROL CIRCUITS FOR STAND-BY OPERATION (See Figure 4-4). Each Model 9511 generates -100 V, referenced to the Model 650 cathode voltage. This is applied to the elevated supply of any plug-in unit not selected for use, by K7 (or K9), to bias the BWO tube to cut-off even though the BWO heater is energized for Standby On mode. (This is necessary because the cathode voltage is applied to all tubes, to provide outgassing when in standby mode to preserve tube life). Each Model 9511 has a separate Standby On mode control circuit for the left- and right-side plug-in units, including a 6 V supply, referenced to the Model 650 cathode voltage, which is switched to drive the heater of the BWO tubes in the Standby On mode. The Standby On mode control circuit also develops a standby condition indication signal for A3-8 in the Model 9510.

4.5.1 DEVELOPMENT OF -100 V GRID CUT-OFF VOLTAGE (See Figure 4-4). The Model 650 cathode supply voltage is supplied continuously to each Model 9511 from the Model 9510 via P5-n and J6-n. This voltage serves as a return for the unregulated -100 V supply in the Model 9511, which includes A1CR7, A1C1, and A1R1. This -100 V is connected by K7 (or K9) - when in the de-energized condition - to drive both the -100 V connection and the transfer oscillator drive connection of the elevated supply in the plug-in unit(s) not selected for rf turn-on as shown in Figure 4-2. This simulates a full grid cut-off signal (normally only supplied by the transfer oscillator) to the elevated supply and causes it to bias the BWO grid to the required negative cut-off voltage. By utilizing the separate Model 9511 -100 V supply, this is accomplished without loading the Model 650 supply. That supply serves only the unit selected for rf output, switched by high voltage relay K7 (or K9) for the selected unit.

4.5.2 DEVELOPMENT OF BWO HEATER POWER FOR STANDBY MODE (See Figure 4-4). Full-wave rectifier A1CR8 developes about 24 V across A1R2. This is filtered and dropped to 7.5 V by A1R3, A1C3, and A1VR1. Since A1VR1 is tied to the Cathode supply line, the output at the junction of A1VR1 and R10 is -7.5 V below cathode supply voltage. The same section of A1CR8 discussed in paragraph 4.5.1 develops -12 V below cathode supply voltage at the junction of A1C2 and A1C4, which is tied to the 12 V center-tap (T1-9) of the T1-8-10 winding. When the STANDBY switch for each plug-in unit is Off, A1Q1 (or A1Q8), which controls turn-on of standby heater power to the tube, receives no forward base bias and is cut off.

If the STANDBY switch for either plug-in unit is in the On position, it connects +12 V from A1CR4/A1CR5 to energize A1DS3 (or A1DS4). This drives the base of A1Q1 (or A1Q8) through A1R7 (or A1R8) toward cathode level while the emitter remains at -7.5 V below cathode, turning on A1Q1 (or A1Q8). When A1Q1 (or A1Q8) turns on, it turns on Darlington stage A1Q17/A1Q18 (or A1Q19/A1Q20). The emitter/base drops in the two Darlington transistors establish an output level of -6.3 V below cathode, since they provide a 1.2 V rise from the -7.5 V at the A1Q1 (or A1Q8) collector. This voltage is supplied to operate the BWO heater, with A1R4 (or A1R5) serving as load resistor. It is connected to the BWO heater by K7 (or K9) when in the de-energized condition only. When K7 or K9 is energized, indicating that the corresponding plug-in unit has been selected for rf output, operation of K7 (or K9) quickly switches to the Model 650 heater supply, so that heater power is provided essentially without interruption if the plug-in unit was already in Standby On mode. (It is necessary to switch over to the Model 650 heater supply for actual plug-in unit operation so that the over-voltage and overcurrent protection provided only by the Model 650 is available to the one BWO operating with cathode current.)

4.5.3 DEVELOPMENT OF "STANDBY CONDITION" SIGNAL FOR THE MODEL 9510 (See Figure 4-4). Transistors A1Q9 through A1Q12 (or A1Q13 through A1Q16) provide the "standby condition" signal for A3-8 in the Model 9510 when the left-hand (or right hand) plug-in unit is selected for rf output. In the following description, only components used in the "left-hand" circuit will be referenced. The "right-hand" circuit operates in an identical manner.

When the STANDBY switch is in the Off position, it shunts A1C6, holding it completely discharged. The (-) side of A1C6 is connected to the ≈ -1.5 V dc developed across A1CR2/A1CR3. The circuit is inoperative because no voltage is applied to the A1R33/A1R20 junction. +12 V is applied through the STANDBY switch to K1-3, to provide the +12 V signal to A3-8 in the Model 9510 if this unit is selected.

When the STANDBY switch is turned On, +12 V is applied to that junction and the A1Q12 emitter is disconnected from the -1.5 V supply. A1Q9 remains cut off because its emitter is back-biased by the connection to +12 V through A1R22. It thus isolates the line connecting to K1-3 to provide the required "floating" condition for the signal supplied to A3-8 in the Model 9510 if selection occurs during the first 90 seconds of Standby On mode when the BWO is warming up. A1DS3 is turned on by the +12 V, since its return to ground is provided through A1CR10 and A1CR11. This turns on heater power to the BWO. The STANDBY light is turned on, but glows dimly since it sees only ≈ 10 V, being connected to ground through A1CR9, A1CR10, and A1CR11.

Meanwhile, A1C6 starts charging toward +12 V through A1R33 and A1R24. The emitter of A1Q12 is biased to ≈ +2 V by the A1R20/A1R21 voltage divider, so that when A1C6 has changed to ≈+2.6 V (90 seconds after Standby On mode was initiated), it turns on A1Q12. This forward-biases A1Q11 which provides a positive-going pulse at its collector to trigger SCR A1Q10 to conduct. Turn-on of A1Q10 ties the A1Q9 emitter to -1.5 V, thereby turning on A1Q9 to provide a "ground level" (slightly negative) signal to K1-3 as required for connection to A3-8 when Standby On mode has been selected for more than 90 seconds. Turn-on of A1Q10 also returns the STANDBY light to -1.5 V, creating a drop across it of >12 V so that it glows brightly.

If the STANDBY switch is turned off, it immediately resets the timer circuit by shunting A1C6 and cutting off all four transistors. Otherwise they remain conducting to maintain the "standby ready" signal.

4.6 OPERATION OF PRESET SWEEP CONTROLS (See Figure 4-5). In the PRESET SWEEP mode, the Model 9510 supplies a relay control signal to switch the frequency control signal(s) for the Model 650 away from the Model 650 F_1 and F_2 panel controls. It then substitutes a 0 to +15 V swept (and/or fixed) signal developed by the Model 9510 Preset Sweep PC board A4, under Control of the PRESET SWEEP knobs on the Model 9511 corresponding to the selected plug-in unit.

When the PRESET SWEEP switch for the selected plug-in unit is On, it provides +12 V to the PRESET SWEEP lamp and switch transistor A2Q1 (or A2Q2). Because the unit has been selected for rf output, the switch transistor base and the lamp are returned to the ground-level "enable" signal, turning on both. The switch transistor then couples +12 V to the Model 9510 via P6-A and J5-A. The Model 9510 couples this signal from J8-D to the Model 650 via the separate preset sweep control cable and J20-D to activate preset sweep relay K5.

Within the Model 650, K5-6 disconnects the +15 V sweep ramp signal from the F_2 Pot R38, and connects it instead to the Model 9510 Preset Sweep board at A4-1, via terminal A of the preset sweep cable connectors. Model 650 K5-9 also disconnects the cathode supply "start frequency" (+) control signal line from the wiper of the F1 pot R41, and connects it instead to receive a signal from the Model 9510 Preset Sweep board at A4-7, via terminal B of the preset sweep cable connectors.

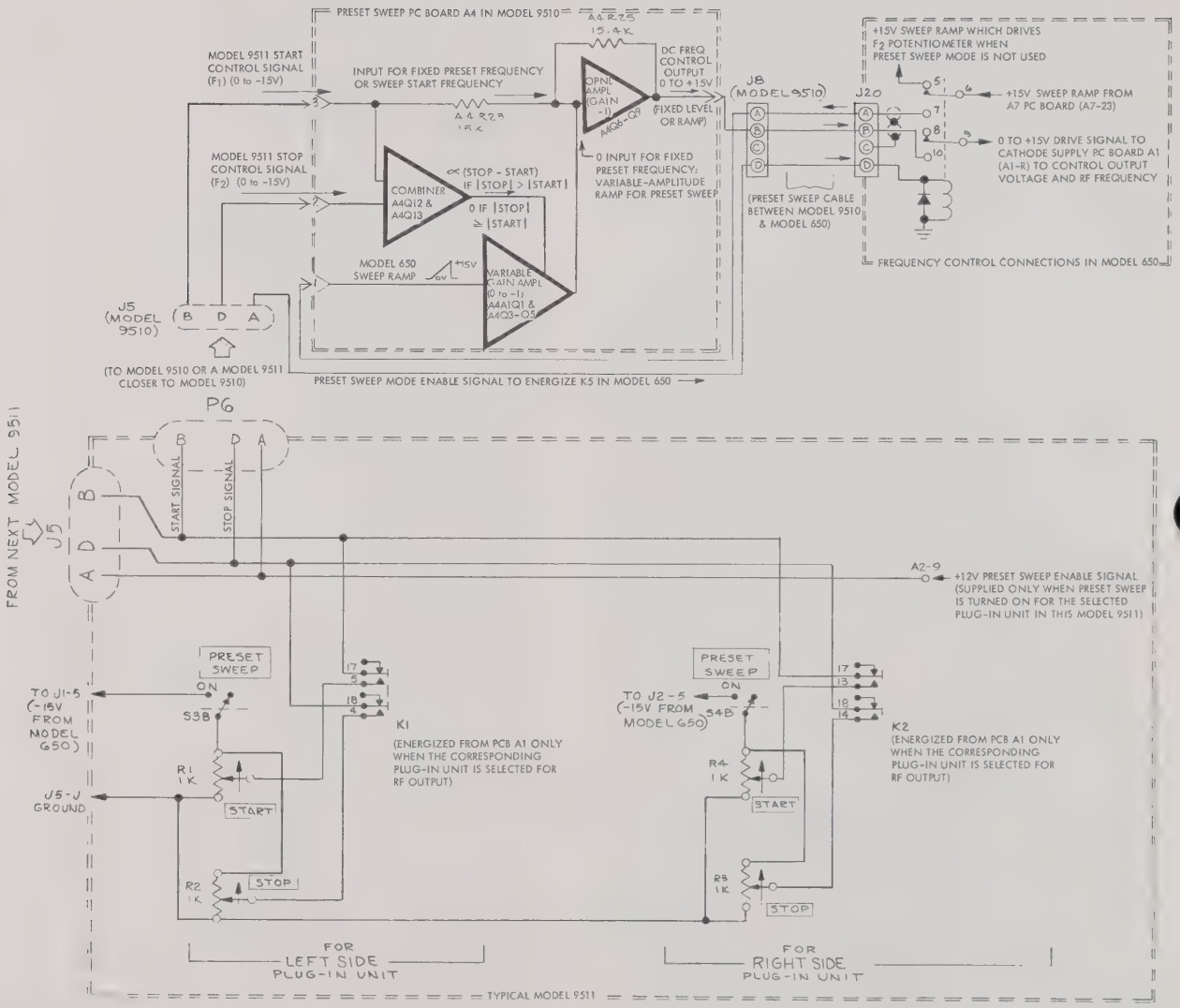

PRESET SWEEP PC BOARD A4 IN MODEL 9510
A4R25
15.4K
MODEL 9511 START CONTROL SIGNAL (F1) (0 to -15V)
INPUT FOR FIXED PRESET FREQUENCY OR SWEEP START FREQUENCY
A4R23
15K
OPNL AMPL (GAIN -1) A4Q6-Q8
DC FREQ CONTROL OUTPUT 0 TO +15V
(FIXED LEVEL OR RAMP)
MODEL 9511 STOP CONTROL SIGNAL (F2) (0 to -15V)
COMBINER A4Q12 & A4Q13
∝ (STOP - START) IF |STOP| > |START|
0 IF |STOP| ≥ |START|
0 INPUT FOR FIXED PRESET FREQUENCY; VARIABLE-AMPLITUDE RAMP FOR PRESET SWEEP
MODEL 650 SWEEP RAMP
+15V
0V
VARIABLE GAIN AMPL (0 to -1) A4A1Q1 & A4Q3-Q5
J5 (MODEL 9510)
B D A
(TO MODEL 9510 OR A MODEL 9511 CLOSER TO MODEL 9510)
PRESET SWEEP MODE ENABLE SIGNAL TO ENERGIZE K5 IN MODEL 650
J8 (MODEL 9510)
(PRESET SWEEP CABLE BETWEEN MODEL 9510 & MODEL 650)
J20
+15V SWEEP RAMP WHICH DRIVES F2 POTENTIOMETER WHEN PRESET SWEEP MODE IS NOT USED
+15V SWEEP RAMP FROM A7 PC BOARD (A7-23)
0 TO +15V DRIVE SIGNAL TO CATHODE SUPPLY PC BOARD A1 (A1-R) TO CONTROL OUTPUT VOLTAGE AND RF FREQUENCY
FREQUENCY CONTROL CONNECTIONS IN MODEL 650
FROM NEXT MODEL 9511
J5
P6
START SIGNAL
STOP SIGNAL
A2-9
+12V PRESET SWEEP ENABLE SIGNAL (SUPPLIED ONLY WHEN PRESET SWEEP IS TURNED ON FOR THE SELECTED PLUG-IN UNIT IN THIS MODEL 9511)
PRESET SWEEP
ON
TO J1-5 (-15V FROM MODEL G50)
S3B
R1 1K
START
J5-J GROUND
R2 1K
STOP
K1
(ENERGIZED FROM PCB A1 ONLY WHEN THE CORRESPONDING PLUG-IN UNIT IS SELECTED FOR RF OUTPUT)
FOR LEFT SIDE PLUG-IN UNIT
TO J2-5 (-15V FROM MODEL G50)
S4B
R4 1K
R3 1K
K2
(ENERGIZED FROM PCB A1 ONLY WHEN THE CORRESPONDING PLUG-IN UNIT IS SELECTED FOR RF OUTPUT)
FOR RIGHT SIDE PLUG-IN UNIT
TYPICAL MODEL 9511

FIGURE 4-5. SIMPLIFIED SCHEMATIC DIAGRAM OF PRESET SWEEP CIRCUITS IN MODELS 9510, 9511, AND 650.

Since the cathode supply receives no "sweep ramp" (+) signal from the de-energized F_2 pot in Preset Sweep mode, it is driven only by the signal supplied by A4-7 in the Model 9510. Thus, the Model 9510 can develop either a single frequency or swept output, by supplying either a fixed voltage anywhere in the range 0 to +15 V, or a positive-going ramp having start and stop voltages anywhere in the 0 to +15 V range, according to the frequencies desired. A4 in the Model 9510 develops this output signal under the control of the Model 9511 PRESET FREQUENCY potentiometers for the selected plug-in unit.

Each pair of Model 9511 PRESET SWEEP potentiometers are connected between -15 V and ground through the individual PRESET SWEEP pushbuttons for each plug-in unit, as shown in Figure 4-5. Only the START and STOP potentiometers for the plug-in unit selected for rf output are connected to control the Model 9510 Preset Sweep board A4, when K1 (or K2) is turned on to activate the corresponding plug-in unit. Thus, the A4 board receives two fixed signals which may be adjusted anywhere in the range 0 to -15 V and the 0 to +15 V Sweep ramp from the 650. It converts these into a single output signal at A4-7, with a range of 0 to +15 V. This signal is a sweep ramp signal which produces a swept rf output between the START and STOP frequencies selected if the STOP control is set higher in frequency than the START control. If the START control is set higher in frequency than the STOP control, the signal is a fixed positive voltage proportional to the setting of the START control. This will generate a single-frequency rf output at the START frequency. (Normally, the STOP control is turned to 0 for single-frequency preset.)

4.6.1 BLOCK DIAGRAM DESCRIPTION OF MODEL 9510 PRESET SWEEP PC BOARD A4 (See Figure 4-5). When the START voltage exceeds the STOP voltage (preset single-frequency mode) the combiner is cut off, which cuts off the variable-gain ramp amplifier, so that the only signal supplied to the operational amplifier is a negative signal proportional to the START control setting. The operational amplifier inverts this signal and supplies a fixed output to the Model 650 in the 0 to +15 V range. For example, if the START control is set at 50% and the STOP control is set at 0%, the START control applies -7.5 V to A4-3, and the operational amplifier develops +7.5 V at A4-7 to drive the Model 650 at its band-center frequency.

When the STOP voltage exceeds the START voltage (preset sweep mode), the input from the START control produces a fixed output drive (just as in preset single-frequency mode) which serves to establish the starting frequency of the sweep; and the combiner output adjusts the variable-gain amplifier to add a sweep ramp of the proper amplitude to drive the output up to the desired STOP frequency. For example, if the START control is set at 30% and the STOP control is set at 80%, the START control applies -4.5 V to A4-3, causing the operational amplifier to develop +4.5 V output drive as a sweep ramp baseline. The STOP control applies -12 V to A4-2, and the combiner responds to the net difference of 7.5V to control the variable gain amplifier to operate at one-half its maximum amplification. The ramp signal thereby coupled to the operational amplifier adds a 0 to +7.5 V ramp to the fixed +4.5 V output level for a combined drive output consisting of a ramp beginning at +4.5 V and increasing to +12 V.

4.6.2 DETAILED DESCRIPTION OF MODEL 9510 PRESET SWEEP PC BOARD A4 (See Schematic D907317). The operational amplifier is comprised of A4Q6 through A4Q9. Transistors A4Q10 and A4Q11 operate as 7.5 V zener diodes. They control the drop between the +100 V and +15 V supplies to establish +30 V bias at the junction of A4R18 and A4R20. This serves as collector bias for differential input stages A4Q6 and A4Q9 of the operational amplifier. The output stage A4Q8 operates between +100 V (through A4R19) and -15 V (through A4R28), and operates with moderate conduction to control the output line over a range of 0 to +15 V.

The base of transistor A4Q6 serves as the input summing junction of the operational amplifier. The START (F_1) input is coupled directly to the summing junction by 15 K summing resistor A4R23. The START input is also applied directly to the base of A4Q13 which serves as the combiner. The STOP (F_2) input is applied through emitter follower A4Q12 to the emitter of combiner A4Q13. Thus, if the negative START input exceeds the negative STOP input, combiner A4Q13 is back-biased and cut off. This cuts off emitter current from A4A1Q1, the differential input stage of the variable-gain amplifier, and prevents if from coupling the sweep ramp signal from A4-1 to the input summing junction via A4Q4.

Whenever the negative STOP input exceeds the negative START input, combiner A4Q13 is biased on, and its conduction is proportional to the difference between the STOP and START signal levels. This conduction controls the current through A4A1Q1, thereby controlling its amplification of the sweep ramp signal applied to its left base. A4Q3 and A4Q4 serve as a differential output stage for the variable-gain amplifier, providing low level summing junction current drive directly from A4Q4 to the base of A4Q6. Transistor A4Q1 serves a constant-current base bias source for A4A1Q1. A4Q5 serves as a constant current source for differential output stage A4Q3/A4Q4.

Potentiometer A4R12 adjusts the quiescent (+) current provided to summing junction from A4Q4 to equal the leakage (-) current supplied through A4R26, thereby achieving a null which produces 0 V output at A4-7 when the START and STOP inputs are both 0. A4R16 adjusts the right-hand base bias of A4Q1Q1 to balance the differential stage to achieve 0 output with 0 input (at the base of the ramp). A4R1 adjusts the attenuation of the sweep ramp to the level which produces +15 V peak output from A4-7 at the peak of the ramp. A4R25 is the operational amplifier feedback resistor, which is selected to provide a gain slightly greater than -1 to compensate for circuit losses and provide a true 0 to +15 V output range. Sweep linearity of the preset sweep circuits is sufficient to operate the Model 650 within its overall 1% linearity spec.

A4A1RT1 is physically mounted on A4A1Q1, and provides temperature compensation for stable calibration. When the temperature rises, A4A1VR1 decreases the emitter current through A4A1Q1 to compensate for its increase of gain with temperature.

SECTION 5

MAINTENANCE

5.1 PERIODIC MAINTENANCE.

Every six months, perform the following maintenance on the system:

a. Remove all accumulated dust from each unit with forced air.

b. Visually inspect the system and each unit for loose or broken connections, damaged cables, loose panel controls or connectors, improperly seated tubes or relays, etc. Replace worn-out components as required.

c. Check system operating voltages in accordance with paragraph 5.2.

d. Make a performance test in accordance with paragraph 2.10.

CAUTION

DO NOT ATTEMPT TO "CHEAT" THE PLUG-IN INTERLOCK OR TO ENERGIZE THE MODEL 650 WITHOUT EITHER THE MODEL 9510 OR AN RF PLUG-IN UNIT INSTALLED. ALL REQUIRED LUBRICATION IS PERFORMED AT THE FACTORY DURING ASSEMBLY. FIELD LUBRICATION SHOULD NOT BE REQUIRED.

5.2 SYSTEM VOLTAGE MEASUREMENTS AT CHASSIS TEST POINTS.

5.2.1 TEST POINT LOCATIONS. Test points are provided on the Model 650 chassis at the outputs of all the low and high voltage supplies and at the output of the transfer oscillator, as shown in Figures 5-1, 5-2, and 5-3 of the Model 650 Instruction Manual. The high voltage supply test points on the Model 650 permit checkout of the actual cathode, anode and heater voltage applied to any plug-in unit when that unit is connected to the Model 650 by selection from the Model 9510 panel. Test points are provided on the left side of each plug-in unit for measurement of the remaining tube electrode voltages. When necessary, these other voltages can be checked by removing the left side panel of the Model 9511 for access to the test points on the plug-in unit to be tested. If a plug-in unit extender, Alfred Model 650E, is available, the plug-in unit can be tested without removing the Model 9511 side panel. First install the extender into any Model 9511 opening in accordance with paragraph 2.5. Then connect the plug-in unit to be tested to the extender with power off, and push the Model 9510 button corresponding to the extender position after power is re-applied.

NOTE: If the Model 650 High Voltage trips off when a particular plug-in unit is selected, wait 10 seconds and press the RESET button on the Model 650 panel. See paragraph 2.10.1-e.

5.2.2 TEST PROGRAM SUMMARY. A check of the supply outputs should be made as the first step in a routine performance check or in locating the cause of malfunction. The low voltage supplies listed in Table 5.1 should be checked first, since the high voltage supplies and most other circuits of the instrument cannot operate properly with out-of-spec low voltages. The low voltage test points are located on the right-hand side of the Model 650 chassis (Figure 5-2 of the Model 650 manual). These voltages are measured with respect to chassis ground (TP3), and any accurate digital meter can be used.

The high voltage test points are located on the left-hand side of the Model 650 chassis (Figure 5-3 of the Model 650 manual). TP12, the transfer oscillator output, is located nearby on the top of the chassis (Figure 5-1 of the Model 650 manual). The cathode supply output (TP6) is measured with respect to chassis ground, and a high-voltage voltmeter or a high-voltage probe must be used. For all other high voltage measurements, the "0 line" (TP10) which is at or near cathode potential is the reference rather than chassis ground, and a floating voltmeter with at least 3000 volts insulation must be used.

The heater supply output between TP7 and TP8 may be measured with high voltage off, using a standard meter.

The lowest cathode supply output voltage, which in some plug-in units is low enough for measurement without an insulated meter, is obtained with a single-frequency setting at the low end of the band. Other high voltage measurements should be made at this setting of the cathode supply to keep the "0 line" voltage as low as possible for safety reasons.

WARNING

THE VOLTAGES AND CURRENT PICKOFFS PERTAINING TO THE PLUG-IN UNIT, AVAILABLE AT TEST POINTS ON THE LEFT SIDE OF THE MODEL 650 CHASSIS AND THE PLUG-IN UNIT, ARE AT HIGH-VOLTAGE LEVELS. SUITABLE HIGH-VOLTAGE MEASUREMENT TECHNIQUES AND PRECAUTIONS MUST BE USED.

5.2.3 LOW VOLTAGE MEASUREMENT PROCEDURE. Proceed as follows:

a. Low Voltage Measurements on the Model 650. Make voltage measurements as directed in Table 5.1 below.

TABLE 5.1 LOW VOLTAGE TEST POINT MEASUREMENTS ON MODEL 650

Measured with Respect to Ground (TP3) with Standard Digital Meter (Listed in Preferred Order of Measurement).

Supply	TP#	DC Voltage & Tolerance	AC Ripple
-15V*	TP4	-15.0000 ±0.0075 V	500 μv maximum
+15V*	TP2	+15.0000 ±0.0075 V	500 μv maximum
+100V	TP1	+100.0 ±3.0 V	2 mv maximum
-50V	TP4	-50 ±2 V	2 mv maximum

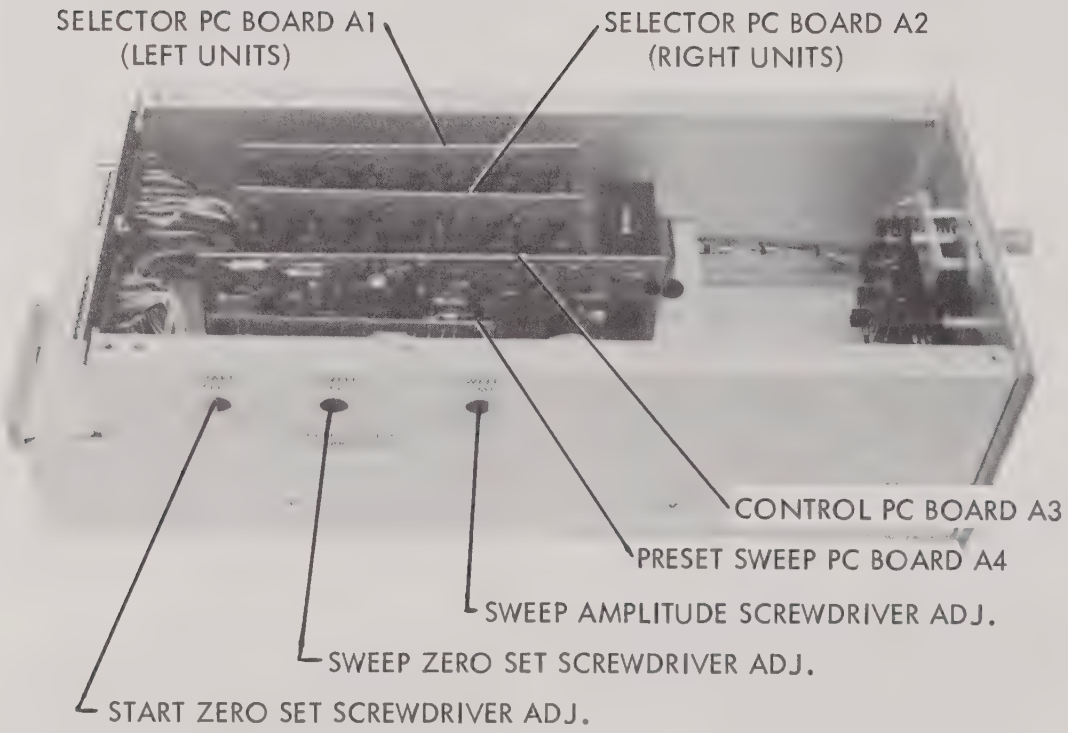


FIGURE 5-1. TOP VIEW OF MODEL 9510 IDENTIFYING PC BOARDS AND SHOWING SCREWDRIVER ADJUSTMENT LOCATIONS ON PRESET SWEEP PC BOARD.

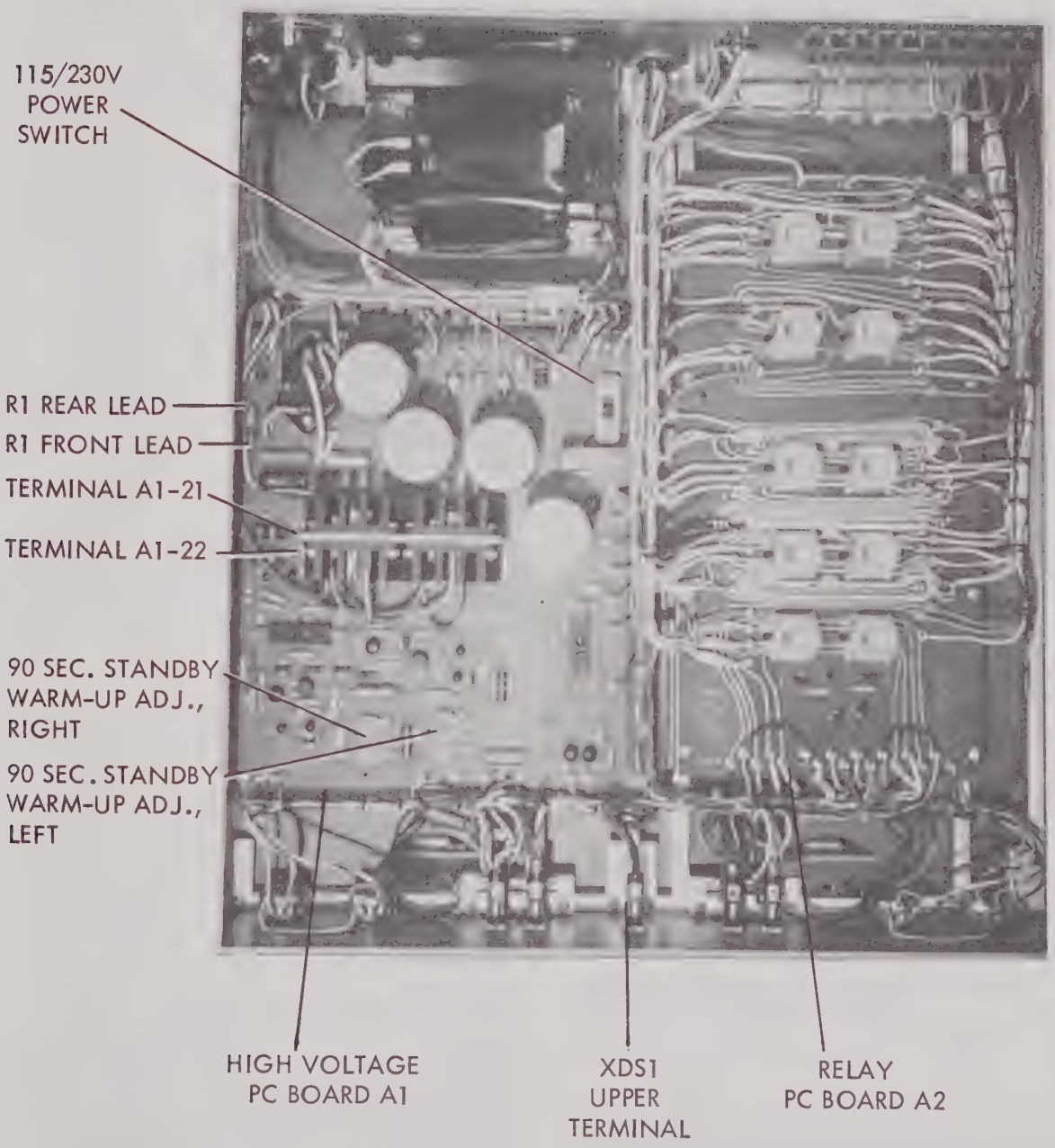


FIGURE 5-2. TOP VIEW OF MODEL 9511 IDENTIFYING PC BOARDS AND SHOWING TEST POINT AND SCREWDRIVER ADJUSTMENT LOCATIONS.

b. Low Voltage Measurements on Each Model 9511.

WARNING

THESE VOLTAGES MUST BE MEASURED WITH POWER ON BUT HIGH VOLTAGE OFF IN THE MODEL 650, SINCE OTHERWISE THEY WILL BE FLOATING AT CATHODE POTENTIAL, EVEN IF NO RF PLUG-IN UNIT HAS BEEN SELECTED FROM THE MODEL 9510. BEFORE PROCEEDING WITH MEASUREMENTS, REMOVE THE TOP COVER OF THE MODEL 650 TO DEFEAT THE HIGH VOLTAGE INTERLOCK AND CHECK THAT THE MODEL 650 HIGH VOLTAGE ON LIGHT REMAINS OFF WHEN THE MODEL 650 POWER SWITCH IS TURNED ON.

There are only four voltage measurements to be made in the Model 9511. The measurement points are accessible when the left side panel is removed (in a rack installation) or when the top cover is removed (in a cabinet installation). Make voltage measurements using a floating, insulated voltmeter, as directed in the following paragraphs. Plug-in units may remain installed for all tests, and must be in Standby On mode for steps (2) and (3) as noted.

(1) -100V Grid Cutoff Supply ((+) to front lead of R1; (-) to rear lead of R1): This is an unregulated voltage having a nominal value of 100V. If the voltage is incorrect, and line voltage is proper, check CR7, C1, and R1.

(2) -6V Heater Supply for Left-Hand Plug-in Unit ((+) to front lead of R1; (-) to High Voltage PCB terminal 21, inboard from R4, to which brown wire attaches): This voltage must be measured when the plug-in unit installed in the left-hand opening is operating in the Standby On mode. With such a load, the voltage should be 5.75 ±0.25 V. If the voltage is incorrect, check VR1, C3, C4, Q1, Q17, Q18 and associated components.

(3) -6V Heater Supply for Right-Hand Plug-in Unit ((+) to front lead of R1, (-) to High Voltage PCB terminal 22, inboard from R5, to which orange wire attaches): This voltage must be measured when the plug-in unit installed in the right-hand opening is operating in the Standby On mode. With such a load, the voltage should be 5.75 ± 0.25 V. If the voltage is incorrect, check VR1, C3, C2, Q8, Q19, Q20 and associated components.

(4) 15V Control Circuit Supply ((+) to upper contact of POWER ON lamp holder XDS1, to which red wire connects, (-) to chassis ground): An alternate (+) connection suitable for measurements when the top cover is removed is High Voltage PCB terminal 38, to the right of C5, to which a red wire attaches. This is an unregulated voltage having a nominal value of 15 V. If the voltage is incorrect, check CR2 and C5, and associated components.

5.2.4 HIGH VOLTAGE MEASUREMENT PROCEDURE. This procedure is divided into two parts. Paragraphs 5.2.4.1 covers the measurements which can be made from the Model 650, and paragraph 5.2.4.2 covers measurements which must be made at the individual plug-in units. Where "Addendum A" is referenced in the following procedures, if refers to the sheet provided for each plug-in unit entitled "Addendum A". This sheet will be found in the envelope at the rear of this manual (or in a separate Plug-in Unit Instruction Manual, if applicable).

NOTE: Reinstall the Model 650 top cover to enable high voltage.

5.2.4.1 CATHODE, HEATER, -100V, AND ANODE HIGH VOLTAGE MEASUREMENT PROCEDURE. These four measurements are made at test points on the Model 650, but they monitor the voltages applied to whichever plug-in unit is selected from the Model 9510 panel. To check operation of all plug-in units, make test connections to the Model 650 for each step with power off and then select each plug-in unit in succession for measurement read-out by pushing the proper buttons on the Model 9510 after power is applied. Wait until the indicator light for the selected unit by the Model 9510 glows brightly, indicating that the unit is generating rf output, before reading the measurement.

a. Cathode Supply Voltage. (TP6 (-) to chassis ground (+)). The proper cathode supply output voltages for the lower and upper band limit frequencies, corresponding to single-frequency settings of 0 and 100 on the logging scale, are given in Addendum A. When a replacement BWO or VTM tube has been installed, refer instead to the new data sheet for that tube which should be attached to Addendum A for permanent reference. For this measurement, the Model 650 FREQUENCY Mode Selector switch must be set to SINGLE, with no modulation applied. Make the dc voltage measurement with a high voltage digital meter or a suitable voltage-divider probe. Refer to Paragraph 5.3.4 of the Model 650 Instruction Manual for measurement of ripple effects.

b. Heater Voltage. (TP7 (+) to TP8 (-)). All BWO tubes utilize less than 1.5 amperes heater current and all VTM tubes use less than 2 amperes. The proper heater voltage with any one of these plug-in units loading the supply is 6.3 V ±0.1 V. It is recommended that this voltage be measured with the high voltage turned off by removing the top or rear panel of the Model 650 to defeat the interlock switch. If the measurement is made with high voltage on, the heater will be at cathode potential, and a floating insulated voltmeter must be used.

c. -100V Supply. (TP10 (+) to TP11 (-)). Voltage should be 100 ±0.1 V. For this measurement, the Model 650 FREQUENCY Mode Selector switch must be set to SINGLE, with no modulation applied. The measurement must be made using a floating, insulated voltmeter.

d. Anode Supply. (TP9 (+) to TP10 (-)). The proper anode supply voltage output setting is given in the Addendum A sheet provided for each plug-in unit in the envelope at the rear of this manual (or in a separate Plug-in Unit Instruction Manual, is applicable). When a replacement BWO or VTM tube has been installed, refer instead to the new data sheet for that tube. The measurement must be made using a floating, insulated voltmeter.

5.2.4.2 GRID, COLLECTOR, AND HELIX VOLTAGE AND CURRENT MEASUREMENTS. All these measurements must be made at the plug-in unit being tested and not at the Model 650 itself. Not all of the measurements given below apply to each type of plug-in unit, as noted. There are three alternate methods to gain access to the test points on the left side of the plug-in unit: (1) Remove the left-hand side panel from one or more Model 9511 units, which permits direct access to the test points and adjustments on the plug-in unit in the left-hand opening. When the left-hand plug-in unit is removed, this also permits access to the test points and adjustments on the left side of the right-hand plug-in unit; (2) Remove the Model 9510 and install the plug-in unit under test directly in the Model 650 plug-in opening; or (3) Use a plug-in extender Model 650E in any

Model 9511 position to permit connection of the rf-type plug-in unit in front of the panel for side access. In any case, all plug-in unit position changes must be made with the Model 650 POWER switch turned off.

NOTE: Plug-in units connected to an extender must be supported at the bottom. The weight of the plug-in unit must not be allowed to rest on the extender connector.

a. Grid Voltage (BWO Plug-in Units Only). (TP10 (+) to TP23 (-)). Voltage should be ≈ 0 V with controls set for RF ON (unmodulated); and 61 ±10 V (for Varian BWO tubes; different if noted on Addendum A) or 26 ±2 V (for Stewart or WJ BWO tubes) with the FREQUENCY Mode Selector switch in the OFF position. The measurement must be made using a floating, insulated voltmeter.

b. Collector Current (Stewart BWO Plug-in Units Only).

NOTE: Collector current cannot be measured on Varian BWO tubes. All beam current is intercepted by the helix. The "Collector Current" test point (TP21) on these plug-in units is non-functional.

(TP1 (+) to TP21 (-)). The proper collector currents in ma for the lower and upper band limit frequencies, corresponding to single-frequency settings of 0, 50, and 100 on the logging scale, are given in Addendum A. When a replacement BWO tube has been installed, refer instead to the new data sheet for that tube.

To measure the collector current, measure the voltage drop between TP1 (+) and TP21 (-). This is the voltage drop produced across a 10Ω resistor by the collector current. Hence, the voltage measured in millivolts must be divided by 10 to obtain the current in milliamperes.

CAUTION

THIS VOLTAGE MEASUREMENT IS AT THE LEVEL OF +100V SINCE TP1 IS THE +100V TEST POINT. THUS, THE VOLTMETER USED MUST BE FLOATING, BUT NEED NOT BE A HIGH-VOLTAGE UNIT.

c. Helix Current (BWO Plug-in Units Only). (TP22 (-), TP3 or chassis ground (+)). The proper helix currents in ma for the lower and upper band limit frequencies, corresponding to single-frequency settings of 0 and 100 on the logging scale, are given in Addendum A. When a replacement tube has been installed, refer instead to the new data sheet for that tube.

NOTE: The helix over-current trip-out level is listed in Addendum A.

Instruments Having Varian BWO Tubes: To measure the helix current, measure the voltage drop between TP22 and TP3 (or chassis ground) with the controls set for RF ON (unmodulated). This is the voltage drop produced across a 10Ω resistance by the helix current. Hence, the voltages measured in millivolts must be divided by 10 to obtain the current in milliamperes. This voltage measurement is at ground level so that a floating or high-voltage voltmeter need not be used.

Instruments Having Stewart (WJ) BWO Tubes. To measure the helix current, measure the voltage drop between TP22 and TP3 (or chassis ground). This is the voltage drop produced across a 100Ω resistance by the helix current. Hence, the voltage measured in millivolts must be divided by 100 to obtain the current in milliamperes. This voltage measurement is at ground level so that a floating or higher-voltage voltmeter need not be used. (If the plug-in unit is an early production unit for which the Addendum A sheet shows neither an "R17 (R20)" nor an A12R15 entry, the voltage is measured across a 10Ω resistance, and division should be by 10 instead of 100.)

d. Anode Current. (Optional test; used only on instruments having Varian BWO tubes.) The maximum allowable anode current and voltage are listed in Addendum A. Operating current level is typically well below the maximum value. To measure the anode current, use a clip-on milliammeter to monitor current in the red lead which connects to terminal 5 of the Elevated Supply PC Board A12.

It is necessary to remove the plug-in unit top cover and operate the unit in an extender plug-in to gain access to the anode lead. Avoid touching the exposed live circuits.

e. Injector Voltage (VTM Plug-in Units Only). (TP21 (+) to TP10 (-)). The proper injector operating voltage when the instrument is operating with the INJECTOR MOD switch OFF, with high voltage applied, is the injector anode voltage given in Addendum A. This same voltage should be maintained when the INJECTOR MOD switch is turned ON, and the controls are set for RF ON (unmodulated). With the INJECTOR MOD switch turned ON and the FREQUENCY Mode Selector switch in the OFF position, the INJECTOR voltage should be -80 V ±1 V (TP21 is then driven negative with respect to TP10). The measurement must be made using a floating, insulated voltmeter.

5.3 INTERNAL ADJUSTMENTS.

5.3.1 MODEL 650 INTERNAL ADJUSTMENTS. If the above system tests of paragraphs 5.2.3 or 5.2.4 indicate that the Model 650 needs adjustment, refer to paragraph 5.3 of the Model 650 Instruction Manual.

If the Model 650 low voltage supplies checked in paragraph 5.2.3 are out of tolerance, or if the high voltage measurements of paragraph 5.2.4 for more than one plug-in unit are out of tolerance, indicating that the defect may be in the Model 650, refer to paragraph 5.3 of the Model 650 Instruction Manual for the appropriate adjustment procedure.

5.3.2 MODEL 650 PLUG-IN UNIT INTERNAL ADJUSTMENTS. If the measurements of paragraphs 5.2.3 or 5.2.4 for an individual plug-in unit are out of tolerance, refer to paragraph 5.3 of the corresponding plug-in unit Instruction Manual for the appropriate adjustment procedure.

5.3.3 MODEL 9510 INTERNAL ADJUSTMENTS. There are only three internal adjustments on the Model 9510, all located on the Preset Sweep PC Board. These adjust the drive voltages supplied to the Model 650 for Preset Sweep Mode operation. These voltages are not subject to change with age, and readjustments should be made only if components are replaced on the Preset Sweep PC Board.

These adjustments are accessible at the left-hand side of the Model 9510 Plug-in Unit, through the access window on the left-hand side of Model 650. If the nature of the rack installation makes it inconvenient to reach this side of the unit, the Model 9510 can be operated inside the Model 650 for voltage measurements, and then temporarily pulled out for making adjustments. Since the adjustments are linear, the incremental change per turn of the screwdriver adjustment can be quickly determined by a trial adjustment, after which the correct final adjustment can be made.

When adjustments are necessary, proceed as follows:

a. Arrange to monitor low voltages at J20, at the upper left rear corner of the Model 650, at its wire terminals inside the chassis, using a digital voltmeter. If this area is not accessible, gain access to the same circuits by disconnecting the cable from J8 at the rear of the Model 9510. Then temporarily jumper terminal A of the cable plug to terminal A of J8, terminal B of the cable plug to terminal B of J8, and terminal D of the cable plug to terminal D of J8, in such a way that voltage measurements can be made at the jumper wires.

b. Make Control Settings as follows on the Model 650:

FREQUENCY Mode Selector to SWEEP $F_1 \rightarrow F_2$
SWEEP TIME to .01
SWEEP TRIGGER to FREE RUN
POWER to ON

c. On the Model 9510, push the select button for any convenient rf plug-in unit.

d. Make Control Settings as follows on the Model 9511, for the plug-in unit selected above.

PRESET SWEEP push button to ON
PRESET SWEEP-START to 0
PRESET SWEEP-STOP to 0

e. Measure the voltage between P20-B (+) (or J8-B) and chassis ground (-). The voltage should be 0.00 V. If the voltage is incorrect, adjust the START ZERO SET screwdriver adjust control, A4R12, to achieve the proper zero output.

f. Turn the SWEEP STOP control to 100.

g. Connect a dc-coupled oscilloscope probe to P20-B (or J8-B), with the return lead to chassis ground. Set the oscilloscope horizontal channel to trigger from the vertical input. Adjust the oscilloscope to obtain a calibrated, expanded display of the sweep sawtooth in order to evaluate the voltage at each end of the ramp.

h. The voltage at the bottom of the ramp monitored in step g above should be 0.00V. If the voltage is incorrect, adjust the SWEEP ZERO SET screwdriver adjust control, A4R16, to achieve this peak value.

i. The voltage at the top of the ramp monitored in step g above should be 15.00 V. If the voltage is incorrect, adjust the SWEEP AMPLITUDE screwdriver adjust control, A4R1, to achieve this peak value.

5.3.4 MODEL 9511 INTERNAL ADJUSTMENTS. There are only two internal adjustments on each Model 9511, both located on the High Voltage PC Board. These adjust the time delay between selection and turn-on of the Standby On mode. The need for adjustment will be evident when this delay interval is not the proper 90 seconds. These adjustments are accessible at the upper front left corner of the unit, either with the top cover or left side panel removed. When gaining access from the side, note that the control for the left-hand plug-in unit is inboard of that for the right-hand plug-in unit.

When adjustments are necessary, proceed as follows:

a. Turn the Model 650 POWER switch ON.

b. Check that both sides of each Model 9511 unit to be checked are initially in the Standby Off mode, and have a plug-in unit installed.

c. While monitoring the second hand of a clock, press both STANDBY buttons on one Model 9511. The STANDBY lights for each side should glow dimly and then become bright after 90 ±15 seconds. If the time delay is outside these limits, turn the proper screwdriver adjust control, 90 SEC ADJUST LEFT (R33) or 90 SEC ADJUST RIGHT (R34), to set the proper delay. A CW adjustment increases the delay.

5.4 TROUBLE SHOOTING.

NOTE: The following material covers system trouble shooting, including switching and control problems traceable to the Model 9510/9511 units. When performance problems are experienced in operating the Model 650 with one or more plug-in units, refer to paragraph 5.4 of the plug-in unit manual for detailed trouble-shooting information on those units.

5.4.1 SYSTEM TROUBLE SHOOTING. Refer to table 5.2.

5.4.2 LOCALIZATION OF TROUBLE TO MODEL 650 AND PLUG-IN UNITS OR MODEL 9510/9511.

5.4.2.1 GENERAL. In difficult situations, a quick way to evaluate whether system trouble is in the Model 650 and/or plug-in units or in the Model 9510/9511 is as follows:

a. Turn the Model 650 POWER switch off.

b. Disconnect all cables from the rear of the Model 9510.

c. Remove the Model 9510 from the Model 650.

d. Install any desired rf plug-in unit directly into the Model 650. If proper operation is then obtained, this isolates the trouble to the Model 9510/9511.

5.4.2.2 PROCEDURE IF TROUBLE IS EXPERIENCED ONLY WITH CERTAIN PLUG-IN UNITS OPERATED IN MODEL 9511 CONTAINERS. If turn-on trouble is experienced with only certain plug-in unit(s), they can be moved to a different Model 9511 location or inserted directly in the Model 650 as described above, to evaluate whether the trouble is in those plug-in unit(s). If these unit(s) then operate properly, the trouble is localized to either the particular Model 9511's where the trouble is experienced, or improper system interconnections, improper set-up switch positions, or Model 9510 trouble in switching circuits for those Model 9511's. Refer to paragraph 5.4.3 for localization of trouble within Model 9510/9511 units.

5.4.2.3 PROCEDURE IF TROUBLE IS EXPERIENCED IN ALL PLUG-IN UNITS OPERATED IN MODEL 9511 CONTAINERS. If trouble is experienced with all plug-in units operated in Model 9511 containers, but not when these plug-in units are operated in the Model 650 itself, the trouble is in the Model 9510 unless there are faulty system interconnections or completely mis-programmed PLUG-IN SET UP SELECTION switches. Inspect for improper interconnections or rear panel switch positions by comparison with Figure 2-1. Then check for defective control or selector circuit boards in the Model 9510.

5.4.3 LOCALIZATION OF TROUBLE WITHIN MODEL 9510/9511 UNITS. When turn-on problems occurring with only some of the plug-in units are localized to the Model 9510/9511 and not the plug-in units themselves, in accordance with paragraph 5.4.2 above, proceed as follows to localize trouble within the Model 9510/9511 units:

a. Inspect system interconnections and PLUG-IN SET UP SELECTION switches in accordance with Figure 2-1. Correct any errors or faults discovered.

b. If step a did not resolve the trouble, make a temporary change in the PLUG-IN SET UP SELECTION switch program-

ing on the rear panel of each Model 9511 unit as a means of evaluating whether the fault is within the switching control circuits in the Model 9510 or the relays in individual Model 9511's. The temporary switch program change may be any arrangement that has only one switch of each particular designation (e.g. L1) in the "up" position anywhere in the system, with the provision that a different L and R switch is in the "up" position on each unit compared to the one used in the standard program. For best evaluation, make temporary switch program changes so that the set-ups on Model 9511 units where problems were observed are transferred to units which were operating properly (e.g. if problems were experienced in turning on L2 or R2, set these up on a Model 9511 where no trouble was experienced). A sample program change is illustrated below:

Standard Program: (Switches listed are "up"; all others are "down".)	Temporary Test Program (Switches listed are "up"; all others are "down".)
Uppermost Model 9511: L1, R1	Uppermost Model 9511: L3, R3
Next Model 9511: L2, R2	Next Model 9511: L4, R4
Next Model 9511: L3, R3	Next Model 9511: L5, R5
Next Model 9511: L4, R4	Next Model 9511: L1, R1
Next Model 9511: L5, R5	Next Model 9511: L2, R2

c. With the temporary test program set up as above, attempt to select (with different buttons) the plug-in unit(s) in the same Model 9511(s) which previously would not turn on. If the same trouble is experienced in the same location(s), the Model 9511(s) are at fault, unless there is interconnection cable failure. If, in this test, trouble is experienced in both sides of a particular Model 9511, the problem is probably failure of the relay or heater supply in that Model 9511. Check supply voltages in the Model 9511 in accordance with paragraph 5.2.3b. If trouble is experienced in only one side of a particular Model 9511, or if voltages are found to be correct when checked, check relay operation in the Model 9511 by observation. If necessary, make a continuity check on the P6 cable captive to the defective Model 9511 and all other P6 cables (if any) between the defective Model 9511 and the Model 9510.

d. If step c indicates no trouble with previously inoperative units, try selecting other units with the Model 9510 buttons which were used to select the "inoperative" units before making the temporary test program change. If these buttons do not properly select the units for which they are now programmed, the Model 9510 is at fault, unless there is interconnection cable failure. Check the selector circuitry corresponding to the defective channels. If necessary, make a continuity check on the P6 cables (if any) between the defective Model 9511 and the Model 9510.

e. Change the PLUG-IN SET UP SELECTION switches on each Model 9511 back to the standard program.

5.4.4 LOCALIZATION OF TROUBLE TO INDIVIDUAL COMPONENTS. Except for the Preset Sweep PC board A4 in the Model 9510, all circuits in the Model 9510 and 9511 are solid-state switching circuits in which the transistors are either turned on to saturation or cut off. The state of any transistor can be quickly determined by measuring its emitter-base voltage or its emitter-collector voltage with a high impedance, floating, insulated voltmeter. Transistors which are "on" will have an emitter-base voltage of ≈ 0.6 V in the forward-bias direction, with negligible emitter-collector voltage drop. Transistors which are "off" will have a reverse-biased emitter-base voltage (or less than 0.6 V forward-bias) and a large emitter-collector voltage drop.

The theory of operation given in Section 4 indicates the proper state of each transistor in each of the operating modes or conditions, and should be thoroughly reviewed as the first step in detailed trouble shooting.

WARNING

SOME CIRCUITS IN THE MODEL 9510 CONTROL PC BOARD A3 OPERATE AT CATHODE POTENTIAL. MOST CIRCUITS IN THE MODEL 9511 OPERATE AT CATHODE POTENTIAL. USE ONLY A FLOATING, INSULATED METER OR OSCILLOSCOPE FOR IN-CIRCUIT MEASUREMENTS, AND EXERCISE EXTREME CAUTION NOT TO TOUCH EXPOSED CIRCUITRY WITH ANY PART OF THE BODY.

TABLE 5.2 TROUBLE-SHOOTING CHART FOR THE MODEL 9510/9511 MULTI-BAND SWEEP OSCILLATOR SYSTEM

Trouble (Indication)	Probable Cause	Remedy
1. Model 650 will not turn on.	a. Improper system power connections.	a. See that connections are made in accordance with Figure 2-1.
	b. Insufficient power available to system (blown fuse or tripped circuit breaker).	b. See that the rack outlet supplying the system can furnish 10 amps.
	c. Plug-in interlock not made.	c. Check latch assembly on 9510 front panel.
2. Model 650 high voltage will not come on. (HIGH VOLTAGE light remains off after power has been on >60 seconds.)	a. Model 9510 unit not properly plugged in or locked in place in Model 650.	a. Check that Model 9510 is fully inserted, and that lock knob is turned fully CW.
	b. Trouble in Model 650.	b. Refer to trouble-shooting information in Model 650 Instruction Manual.
	c. Short in "helix over-currenting" sensing wire.	c. Check continuity. (See Figure 4-10 in Model 650 manual.)
	d. Short in "H.V. OFF" control wire.	d. Check continuity. (See Figures 4-2 and 4-10 in Model 650 manual.)
3. One or more rf plug-in units will not turn on when selected from Model 9510; but some rf plug-in units work properly.	a. Improper system interconnections.	a. See that connections are made in accordance with Figure 2-1.
	b. Plug-in unit not properly inserted in Model 9511.	b. Check that plug-in unit is fully inserted, and that lock knob is turned fully CW. CAUTION MODEL 650 POWER SWITCH MUST BE TURNED OFF WHEN REMOVING OR INSERTING PLUG-IN UNITS.
	c. Improper condition of PLUG-IN SET UP SELECTION switches on any Model 9511 rear panel (not necessarily the one where trouble occurs).	c. Check that these switches are positioned in accordance with paragraph 2.8 and Figure 2-1.
	d. Blown fuse F1 at rear of Model 9511 container for that unit.	d. Check and replace as necessary.
	e. Relay malfunction in Model 9511 or selector circuit malfunction in Model 9510.	e. Refer to paragraph 5.4.3 to localize trouble to the Model 9510 or Model 9511, and check for defective switching circuits or relays.
	f. BWO heater power supply trouble in Model 9511.	f. Make supply voltage checks in accordance with paragraph 5.2.3 b. If voltage is present, check the supply and switching circuitry on the high voltage PC board, and replace components as necessary.
	g. Defective plug-in unit or BWO or VTM tube.	g. Make voltage measurements as directed in paragraph 5.2.4 of this manual. Evaluate microwave tube in accordance with paragraph 5.4 of the plug-in unit manual.
4. No rf plug-in units will turn on when selected from Model 9511.	a. Improper system interconnections.	a. See that connections are made in accordance with Figure 2-1.
	b. Improper condition of PLUG-IN SET UP SELECTION switches on any Model 9511 rear panel.	b. Check that these switches are positioned in accordance with paragraph 2.8 and Figure 2-1.
	c. Trouble in Model 650.	c. Make voltage measurements in accordance with paragraph 5.2 of Model 650 Instruction Manual.
	d. Control or selector circuit malfunction in Model 9510.	d. Check circuits and replace defective components.

TABLE 5.2 TROUBLE-SHOOTING CHART FOR THE MODEL 9510/9511 (CONTINUED)

Trouble (Indication)	Probable Cause	Remedy
5. Selected unit "drops out" during operation when another unit has not been selected.	a. Relay malfunction in Model 9511.	a. Try interchanging plug-in units to different container locations. (Different units have differing magnetic fields in operation.) If this does not solve the problem, check relays in the Model 9511 where trouble occurs.
	b. Malfunctioning Selector circuit in Model 9510.	b. Check control and selector circuits in Model 9510.
6. Preset sweep inoperative on all units; sweep functions properly when controlled by Model 650.	a. Defective preset sweep PC board in Model 9510.	a. Check preset sweep PC board and replace defective components.
	b. Defective or loose cable between J8 of the Model 9510 and J20 of the Model 650.	b. Check cable connections per Figure 2-1. Check cable for continuity.
	c. Defective preset sweep relay in Model 650.	c. Check relay.
7. Preset sweep inoperative only on some unit(s); sweep functions properly when controlled by Model 650.	a. Defective preset sweep switching circuitry in the Model 9511 containing "inoperative" plug-in unit.	a. Check the preset sweep control circuits on the High Voltage PC board, and the relays on the relay RC board, in the Model 9511.
8. Frequency output controlled by PRESET SWEEP controls differs in frequency from that controlled by Model 650 controls set at corresponding points on "logging" scale.	a. Improper adjustment of preset sweep PC board in Model 9510.	a. Check and adjust in accordance with paragraph 5.3.3.
	b. Defective preset sweep PC board in Model 9510.	b. Check preset sweep PC board.
	c. Defective or loose cable between J8 of the Model 9510 and J20 of the Model 650.	c. Check cable connections per Figure 2-1. Check cable for continuity.
9. High voltage drops out when a particular plug-in is selected.	a. Older style anode over-current protection circuit installed in plug-in unit.	a. Remove old circuit and install new circuitry. (Contact factory for free retrofit kit.)

SECTION 6

PARTS LIST

LIST OF ASSEMBLIES

MODEL 9510			
Circuit Reference	Description	Alfred Part No.	Schematic No.
	Main Chassis Assembly		D907319
A1	Selector PC Board	951705	D907316
A2	Selector PC Board	951705	D907316
A3	Control PC Board	951706	D907318
A4	Preset Sweep PC Board	951704	D907317
MODEL 9511			
	Main Chassis Assembly		D907321
A1	Power Supply PC Board	951694	D907320
A2	Relay PC Board	951697	D907314

9510 MAIN CHASSIS ASSEMBLY

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
C1	13-65	Capacitor, fixed, elect., 1000 mf, 25 V
CR1 thru CR10	81-41	Diode, 1N459
CR11	81-20	Diode, 1N4385
CR12 thru CR15	81-216	Diode, 1N4002
CR16 thru CR29		Not used
CR30	81-20	Diode, 1N4385
DS1 thru DS10	126	Lamp, 6 V
J1 and J2	133-63	Connector, Printed wiring, 22 pin
J3	133-95	Connector, Printed wiring, 28 pin
J4	133-62	Connector, Printed wiring, 10 pin
J5	133-102	Connector, Rectangular, 50 pin
J6 and J7	133-71	Connector, Blue ribbon, 16 pin
J8	133-13	Connector, 4 pin
J9	133-104	Connector, 14 pin
J10 thru J19		Not used
J20	133-13	Connector, 4 pin, female
K5	106-42	Relay
P1 and P2	133-14	Connector, 4 pin, male
Q1	81-148	Transistor, 2N4918
S1 thru S10	101-33	Switch Assembly
T1	91-212	Transformer
XDS1 thru XDS10	127-10	Holder, lamp

SELECTOR ASSEMBLY 951705 (PC Board A1)

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
A1CR1	81-41	Diode, 1N459
A1CR2	81-20	Diode, 1N4385
A1CR3 thru A1CR5		Same as A1CR1
A1CR6		Same as A1CR2
A1CR7		Same as A1CR1
A1CR8		Same as A1CR2
A1CR9 thru A1CR11		Same as A1CR1
A1CR12		Same as A1CR2
A1CR13		Same as A1CR1
A1CR14		Same as A1CR2
A1CR15		Same as A1CR1
A1Q1	81-137	Transistor, 2N3568
A1Q2	81-214	Transistor, 2N5143
A1Q3 thru A1Q6	81-215	Transistor, 2N5134
A1Q7		Same as A1Q2
A1Q8 and A1Q9		Same as A1Q1
A1Q10		Same as A1Q2
A1Q11 thru A1Q14		Same as A1Q3
A1Q15		Same as A1Q2
A1Q16 and A1Q17		Same as A1Q1
A1Q18		Same as A1Q2
A1Q19 and A1Q20		Same as A1Q3
A1R1	51-270 Ω	Resistor, fixed, dep. carb., 270 Ω, 1/2 w, ±5%
A1R2	51-680 Ω	Resistor, fixed, dep. carb., 680 Ω, 1/2 w, ± 5%
A1R3	51-1 K	Resistor, fixed, dep. carb., 1 K, 1/2 w, ± 5%
A1R4 and A1R5	51-6.8 K	Resistor, fixed, dep. carb., 6.8 K, 1/2 w, ± 5%
A1R6		Same as A1R2
A1R7		Same as A1R3
A1R8 and A1R9		Same as A1R1
A1R10		Same as A1R2
A1R11		Same as A1R3
A1R12 and A1R13		Same as A1R4
A1R14		Same as A1R2
A1R15		Same as A1R3
A1R16 and A1R17		Same as A1R1
A1R18		Same as A1R2
A1R19		Same as A1R3
A1R20 thru A1R25		Same as A1R4
A1R26 thru A1R30	51-10K	Resistor, fixed, dep. carb., 10K, 1/2 w, 5%

SELECTOR ASSEMBLY 951705 (PC Board A2)

Same as above assembly

CONTROL ASSEMBLY 951706 (PC Board A3)

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
A3C1	13-68	Capacitor, fixed, elect. 3.3 mf, 15 V
A3C2	13-49	Capacitor, fixed, elect., 50 mf, 25 V
A3C3	12-34	Capacitor, fixed, ceramic, .1 mf, 100 V, +80/-20%
A3C4		Not used
A3C5		Same as A3C2
A3C6		Same as A3C2
A3C7	13-59	Capacitor, fixed, elect., 100 mf, 15 V
A3CR1 thru		
A3CR10	81-41	Diode, 1N459
A3CR11 &		
A3CR12		Not used
A3CR13 thru		
A3CR16		Same as A3CR1
A3CR17	81-135	Diode, Eh 400
A3CR18 thru		
A3CR20		Not used
A3CR21 and		
A3CR22		Same as A3CR1
A3CR23	81-20	Diode, 1N4385
A3CR24 and		
A3CR25		Same as A3CR1
A3CR26		Not used
A3CR27		Same as A3CR1
A3DS1	126-15	Lamp, 10 V, Type 10 CS
A4Q1 and		
A3Q2	81-215	Transistor, 2N5134
A3Q3	81-114	Transistor, 2N3638A
A3Q4	81-214	Transistor, 2N5143
A3Q5		Same as A3Q1
A3Q6	81-137	Transistor, 2N3568
A3Q7 and		
A3Q8		Same as A3Q1
A3Q9		Same as A3Q6
A3Q10		Same as A3Q1
A3Q11		Same as A3Q4
A3Q12		Same as A3Q1
A3Q13		Same as A3Q4
A3Q14 and		
A3Q15		Same as A3Q1
A3Q16	81-172	Transistor, 2N4248
A3Q17		Same as A3Q1
A3Q18		Same as A3Q4
A3Q19		Same as A3Q6
A3Q20		Same as A3Q1
A3Q21	81-201	Photo Transistor, L14B
A3Q22		Same as A3Q4
A3Q23	81-181	Transistor, 2N4889
A3Q24		Same as A3Q4
A3Q25		Same as A3Q6
A3Q26 and		
A3Q27		Same as A3Q4
A3Q28		Same as A3Q1
A3R1 thru		
A3R11	56-2.05 K	Resistor, fixed, MF, 2.05 K, 1/2 w, ±1%
A3R12	51-10K	Resistor, fixed, dep. carb., 10 K, 1/2 w, 5%
A3R13	51-3.9 K	Resistor, fixed, dep. carb., 3.9 K, 1/2 2, 5%
A3R14	51-330 Ω	Resistor, fixed, dep. carb., 330 Ω, 1/2 w, 5%
A3R15	51-1 K	Resistor, fixed, dep. carb., 1 K, 1/2 w, 5%

CONTROL ASSEMBLY (PC Board A3) con'd.

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
A3R16	56-1.69 K	Resistor, fixed M.F., 1.69 K, 1/2 w, 1%
A3R17	56-2.32 K	Resistor, fixed, dep. carb., 2.32 K, 1/2 w, 5%
A3R18	51-3.3 K	Resistor, fixed, dep. carb., 3.3.K 1/2 w, 5%
A3R19 and		
A3R20		Same as A3R15
A3R21	51-10 K	Resistor, fixed, dep. carb., 10 K, 1/2 w, ± 5%
A3R22 and		
A3R23		Same as A3R15
A3R24	51-470 Ω	Resistor, fixed, dep. carb., 470 Ω, 1/2 w, ± 5%
A3R25	51-4.7 K	Resistor, fixed, dep. carb., 4.7 K, 1/2 w, ±5%
A3R26	51-1.8 K	Resistor, fixed, dep. carb., 1.8 K, 1/2 w, ±5%
A3R27 and		
A3R28		Same as A3R15
A3R29	51-560 Ω	Resistor, fixed, dep. carb., 560 Ω, 1/2 w, ±5%
A3R30	51-5.6 K	Resistor, fixed, dep. carb., 5.6 K, 1/2 w, ±5%
A3R31	51-2.2 K	Resistor, fixed, dep. carb., 2.2 K, 1/2 w, ±5%
A3R32	56-2.49 K	Resistor, fixed, MF, 2.49 K, 1/2 w, ± 1%
A3R33	56-8.45 K	Resistor, fixed, MF, 8.45 K, 1/2 w, ± 1%
A3R34		Same as A3R31
A3R35		Same as A3R12
A3R36	51-1.5K	Resistor, fixed, dep. carb., 1.5K, 1/2 w, 5%
A3R37	41-3.3 M	Resistor, fixed, comp., 3.3 M, 1w, 10%
A3R38	51-100 Ω	Resistor, fixed, dep. carb., 100 Ω, 1/2 w, ±5%
A3R39		Same as A3R12
A3R40		Same as A3R15
A3R41	51-15 K	Resistor, fixed, dep. carb., 15 K, 1/2 w, ±5%
A3R42	51-6.8 K	Resistor, fixed, dep. carb., 6.8 K, 1/2 w, ±5%
A3R43		Same as A3R30
A3R44	51-270 Ω	Resistor, fixed, dep. carb., 270 Ω, 1/2 w, ±5%
A3R45		Same as A3R15
A3R46	51-22 K	Resistor, fixed, dep. carb., 22 K, 1/2 w, ±5%
A3R47	51-100 K	Resistor, fixed, dep. carb., 100 K, 1/2 w, ±5%
A3R48		Same as A3R29
A3R49	61-29	Resistor, fixed, WW, 27 Ω, 5 w, ± 5%
A3R50		Same as A3R31
A3R51		Same as A3R15
A3R52		Same as A3R38
A3R53		Same as A3R46
A3R54		Same as A3R15
A3R55		Same as A3R24
A3R56 and		
A3R57		Same as A3R42
A3R58		Same as A3R15
A3VR1	81-139	Diode, Zener, 1N4736A
A3VR2	81-204	Diode, Zener, 1N4740A
A3VR3	81-205	Diode, Zener, 1N4744A
A3VR4	81-183	Diode, Zener, MZ-500-11

PRE-SET SWEEP ASSY. 951704 (PC Board A4)

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
A4C1	12-13	Capacitor, fixed, ceramic, .005 mf, 500 V, ± 10%
A4Q1	81-115	Transistor, 2N3565
A4Q2		Not used
A4Q3 thru A4Q5	81-172	Transistor, 2N4248
A4Q6		Same as A4Q1
A4Q7 and A4Q8		Same as A4Q3
A4Q9		Same as A4Q1
A4Q10 and A4Q11		Same as A4Q3
A4Q12 and A4Q13		Same as A4Q1
A4R1	71-144	Resistor, variable, 10K, 25 turn
A4R2	51-8.2 K	Resistor, fixed, dep. carb., 8.2 K, 1/2w, ± 5%
A4R3	56-6.49 K	Resistor, fixed, MF, 6.49 K, 1/2 w, ± 1%
A4R4	56-1 K	Resistor, fixed, MF, 1 K, 1/2 w, ± 1%
A4R5	51-470 Ω	Resistor, fixed, dep. carb., 470 Ω, 1/2 w, ± 5%
A4R6	56-20 Ω	Resistor, fixed, MF, 20 Ω, 1/2 w, ± 1%
A4R7	56-10 K	Resistor, fixed, MF, 10 K, 1/2 w, ± 1%
A4R8	56-4.99 K	Resistor, fixed, MF, 4.99 K, 1/2 w, ± 1%
A4R9	56-4.53 K	Resistor, fixed, MF, 4.53 K, 1/2 w, ± 1%
A4R10 and A4R11	56-1.47 K	Resistor, fixed, MF, 1.47 K, 1/2 w, ± 1%
A4R12	71-143	Resistor, variable, 500 Ω, 25 turn
A4R13	56-3.09K	Resistor, fixed, MF, 3.09K, 1/2 w, 1%
A4R14		Same as A4R9
A4R15	56-10K	Resistor, fixed, MF, 10K, 1/2w, ±1%
A4R16		Same as A4R1
A4R17	51-100 K	Resistor, fixed, dep. carb., 100 K, 1/2w, ±5%
A4R18	43-10 K	Resistor, fixed, comp., 10 K, 2 w, ± 10%
A4R19	42-22 K	Resistor, fixed, comp., 22 K, 1 w, ± 10%
A4R20		Same as A4R17
A4R21	56-11.5 K	Resistor, fixed, MF, 11.5 K, 1/2 w, ± 1%
A4R22	56-8.25 K	Resistor, fixed, MF, 8.25 K, 1/2 w, ± 1%
A4R23	56-15 K	Resistor, fixed, MF, 15 K, 1/2 w, ± 1%
A4R24		Same as A4R6
A4R25	56-14.7K	Resistor, fixed, MF, 14.7K, 1/2w, ±1%
A4R26		Same as A4R7
A4R27	56-75 K	Resistor, fixed, MF, 75 K, 1/2 w, ± 1%
A4R28	51-33 K	Resistor, fixed, dep. carb., 33 K, 1/2 w, ±5%
A4R29	56-15.4K	Resistor, fixed, MF, 15.4K, 1/2w, ±1%
A4R30	51-1 K	Resistor, fixed, dep. carb., 1K, 1/2 w, ± 5%
A4R31		Same as A4R15
A4A1Q1	81-113	Transistor, dual, 2N4956
A4A1RT1	40-4	Thermistor, 100KΩ, GE Type 4D101

9511 MAIN CHASSIS ASSEMBLY

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
DS1 thru DS7	126-21	Lamp, 12 V
F1	121-14	Fuse, 2A
J1 thru J4	133-72	Connector, Blue Ribbon, 16 pin
J5	133-102	Connector, rectangular, jack, 50 pin
J7	132-14	Socket, a c, w/mounting plate
P6	133-101	Connector, rectangular, plug, 50 pin
P8	142-4	Power cord assembly
Q18	81-200	Transistor, 2N4904
Q20		Same as Q18
R1 thru R4	71-78	Resistor, variable, 1 K, 2 w
S1 thru S4	101-32	Switch, Push button
S5 and S6	101-21	Switch, Interlock
S7 thru S16	102-136	Switch, slide
T1	91-211	Transformer, power
XDS1 thru XDS7	127-10	Holder, lamp
XF1	122-1	Holder, fuse

POWER SUPPLY ASSY. 951694 (PC Board A1)

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
A1C1	13-76	Capacitor, fixed, elect., 300 mf, 150 V
A1C2 and A1C3	13-77	Capacitor, fixed, elect., 4600 mf, 15 V
A1C4	13-59	Capacitor, fixed, elect., 100 mf, 15 V
A1C5		Same as A1C2
A1C6 and A1C7	13-49	Capacitor, fixed, elect., 50 mf, 35 V
A1CR1	81-216	Diode, IN4002
A1CR2 thru A1CR5	81-199	Diode, IN4720
A1CR6	81-41	Diode, IN459
A1CR7	81-219	Diode, MDA 920A-4
A1CR8	81-157	Diode, MDA 952-1
A1CR9 thru A1CR14		Same as A1CR1
A1CR15		Not used
A1CR16		Same as A1CR6
A1DS1 thru A1DS4	126-15	Lamp, 10CS
A1K1	106-41	Relay, DPST, 12 VDC coil
A1Q1	81-215	Transistor, 2N5134
A1Q2 and A1Q3	81-137	Transistor, 2N3568
A1Q4 thru A1Q7	81-201	Photo Transistor, L14B

POWER SUPPLY ASSY (PC Board A1) con'd.

CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
A1Q8		Same as A1Q1
A1Q9		Same as A1Q2
A1Q10	81-147	Transistor, C6G
A1Q11	81-115	Transistor, 2N3565
A1Q12	81-172	Transistor, 2N4248
A1Q13		Same as A1Q2
A1Q14		Same as A1Q10
A1Q15		Same as A1Q11
A1Q16		Same as A1Q12
A1Q17	81-148	Transistor, 2N4918
A1Q18	81-200	Transistor, 2N4904
A1Q19		Same as A1Q17
A1Q20		Same as A1Q18
A1R1	43-100 K	Resistor, fixed, comp., 100 K, 2w, 10%
A1R2	61-27	Resistor, fixed, WW, 500 Ω, 5w, 5%
A1R3	61-28	Resistor, fixed, ww, 300Ω, 8w, 5%
A1R4 and A1R5	43-56 Ω	Resistor, fixed, comp, 56 Ω, 2 w, 10%
A1R6	43-220 Ω	Resistor, fixed, comp., 220 Ω, 1/2 w, 5%
A1R7 and A1R8	51-220 Ω	Resistor, fixed, dep. carb., 220 Ω, 1/2 w, 5%
A1R9 thru A1R11	51-1 K	Resistor, fixed, dep. carb., 1 K, 1/2 w, 5%
A1R12 thru A1R15		Same as A1R7
A1R16		Same as A1R9
A1R17	51-120Ω	Resistor, fixed, dep. carb., 120Ω, 1/2 w, 5%
A1R18	51-680K	Resistor, fixed, dep. carb., 680K, 1/2 w, 5%
A1R19	51-68 Ω	Resistor, fixed, dep. carb., 68 Ω, 1/2w, 5%
A1R20	56-11.8 K	Resistor, fixed, MF, 11.8 K, 1/2 w, 1%
A1R21	56-4.64 K	Resistor, fixed, MF, 4.64 K, 1/2 w, 1%
A1R22	51-1.2 K	Resistor, fixed, dep. carb., 1/2 w, 5%
A1R23	51-680 K	Resistor, fixed, dep. carb., 680 K, 1/2 w, 5%
A1R24	42-2.7M	Resistor, fixed, comp., 2.7M, 1 w, 10%
A1R25		Same as A1R17
A1R26		Same as A1R22
A1R27		Same as A1R19
A1R28		Same as A1R20
A1R29		Same as A1R21
A1R30 and A1R31	51-270 Ω	Resistor, fixed, dep. carb., 270 Ω, 1/2 w, 5%
A1R32		Same as A1R24
A1R33 and A1R34	71-128	Resistor, variable, 1 M, 1w
A1S1	102-156	Switch, slide
A1VR1	81-206	Diode, Zener, 1N4737A

RELAY ASSEMBLY 951697 (PC Board A2)

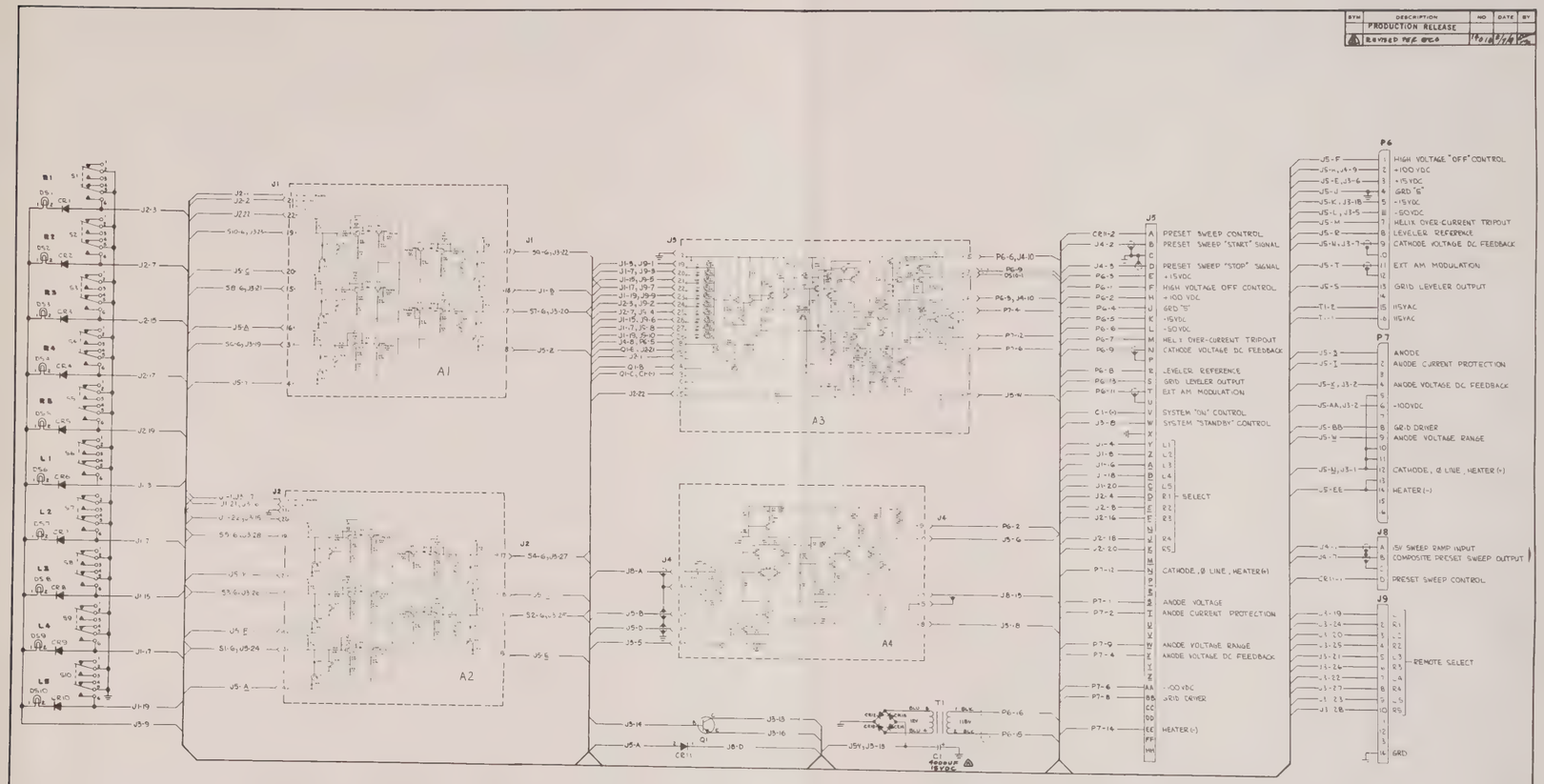
CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION
A2CR1 thru A2CR8	81-216	Diode, IN4002
A2K1 thru A2K10	106-40	Relay, 4PDT, Printac
A2Q1 and A2Q2	81-214	Transistor, 2N5143
A2R1 and A2R2	51-1.5 K	Resistor, fixed, dep. carb., 1.5 K, 1/2 w, 5%

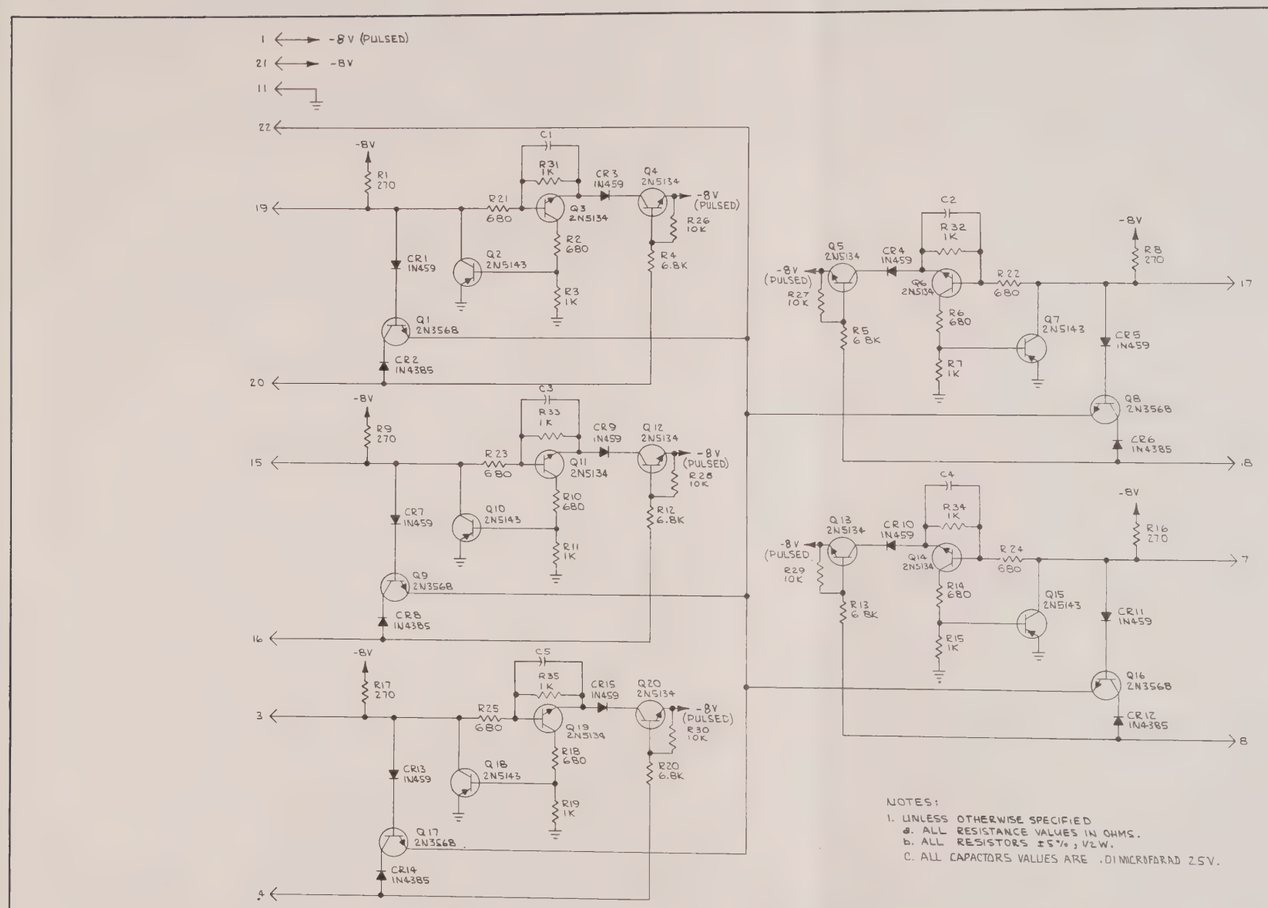
SECTION 7

SCHEMATIC DIAGRAMS

SCHEMATICS ARE INCLUDED IN THE FOLLOWING ORDER

MODEL 9510			
Circuit Reference	Description	Alfred Part No.	Schematic No.
	Main Chassis Assembly		D907319
A1 & A2	Selector PC Board	951705	D907316
A3	Control PC Board	951706	D907318
A4	Preset Sweep PC Board	951704	D907317
MODEL 9511			
	Main Chassis Assembly		D907321
A1	Power Supply PC Board	951694	D907320
A2	Relay PC Board	951697	D907314


SYM | DESCRIPTION | NO | DATE | BY
PRODUCTION RELEASE
REVISED PER ECO
A1
A2
A3
A4
P6
P7
J8
J9
J5
J1
J2
J3
J4
T1
HIGH VOLTAGE "OFF" CONTROL
+100 VDC
+15 VDC
GRID "G"
-15 VDC
-50 VDC
HELIX OVER-CURRENT TRIPOUT
LEVELER REFERENCE
CATHODE VOLTAGE DC FEEDBACK
EXT AM MODULATION
GRID LEVELER OUTPUT
115 VAC
ANODE
ANODE CURRENT PROTECTION
ANODE VOLTAGE DC FEEDBACK
GRID DRIVER
ANODE VOLTAGE RANGE
CATHODE, Ø LINE, HEATER(+)
HEATER(-)
PRESET SWEEP CONTROL
PRESET SWEEP "START" SIGNAL
PRESET SWEEP "STOP" SIGNAL
SYSTEM "ON" CONTROL
SYSTEM "STANDBY" CONTROL
L1
L2
L3
L4
L5
R1 - SELECT
R2
R3
R4
R5
REMOTE SELECT
SWEEP RAMP INPUT
COMPOSITE PRESET SWEEP OUTPUT
PRESET SWEEP CONTROL
GRID
NOTES:
1. A1, A2, A3, & A4 SCHEMATICS ARE FOR REF ONLY, SEE DETAIL SCHEMATICS FOR EXACT COMPONENT VALUE & TYPES (A1 & A2 - 907B16, A3 - 907B18, A4 - 907B17.)
2. COMPONENT VALUES:
CR1 THRU CR10 = 1N459
CR11 THRU CR15 = 1N4002
Q1 = 2N6918
DS1 THRU DS10 = 6 VDC, 40 MA LAMP P/N 126-22
LIST OF MATERIAL
SCHEMATIC
MODEL 9510
ALFRED ELECTRONICS
PALO ALTO CALIFORNIA
DIMENSIONS ARE IN INCHES
TOL. XX ± .015 XXX ± .005 ANGLE ± ½
UNLESS INDICATED OTHERWISE
SIZE D 907319 REV A
SHEET 1 OF 1



NOTES:

1. UNLESS OTHERWISE SPECIFIED
   a. ALL RESISTANCE VALUES IN OHMS.
   b. ALL RESISTORS ±5%, ½W.
   c. ALL CAPACTORS VALUES ARE .01 MICROFARAD 25V.

HIGHEST REFERENCE DESIGNATIONS			
R34	Q20	CR15	C5

REFERENCE DESIGNATIONS NOT USED

BYM	DESCRIPTION	NO	DATE	BY
	PRODUCTION RELEASE	2515		

ITEM	REQD	PART NO	DESCRIPTION
			LIST OF MATERIAL

951705 / 9510
NEXT ASSY / USED ON

MATERIAL: —
MATERIAL SPECIFICATION: —
FINISH OR TREATMENT: —

DRAWN: Louise Kodama 9/13/66
CHECK:
ENG: [illegible] 9/13/66
PROD:
SCALE: —

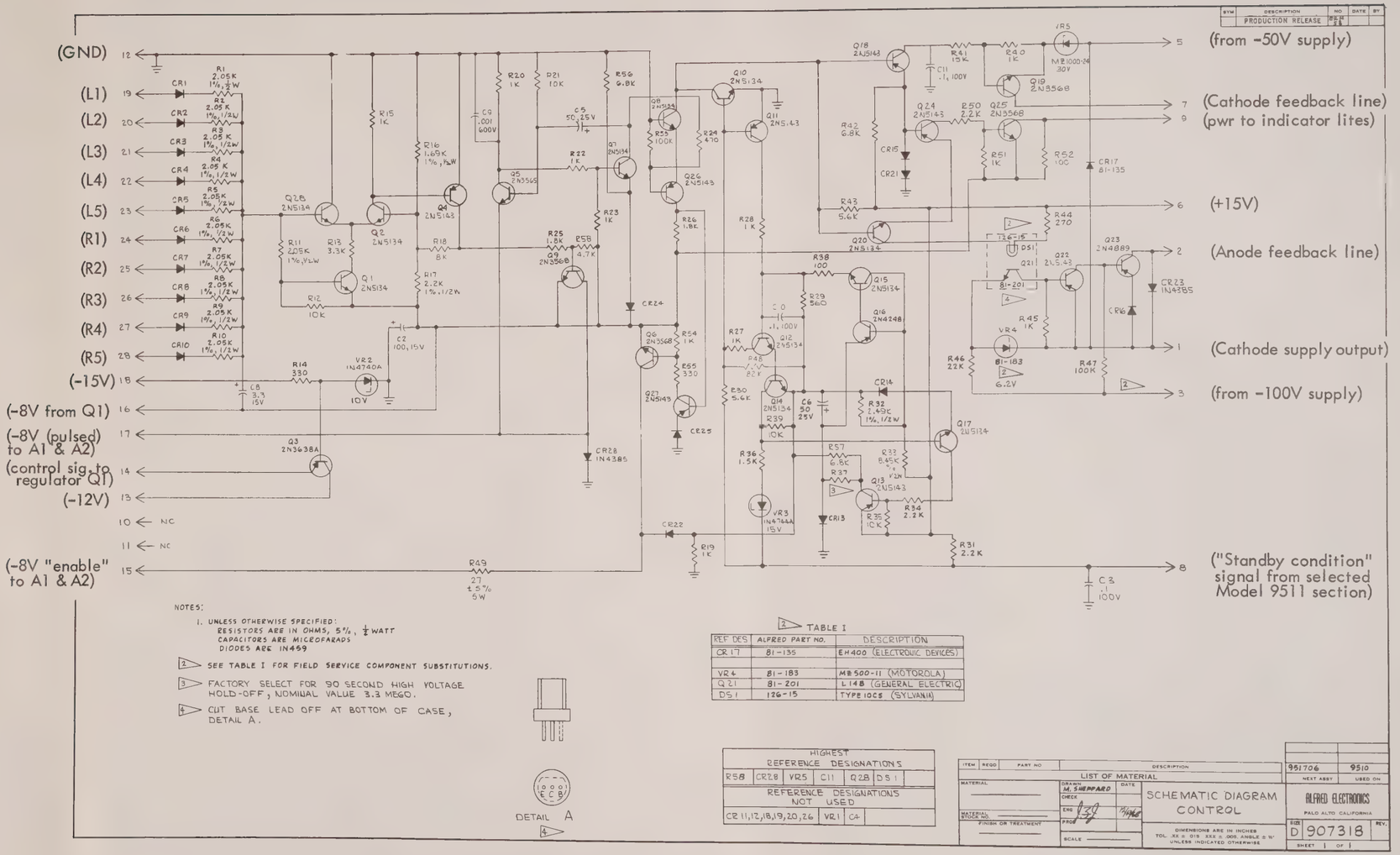
DIMENSIONS ARE IN INCHES
TOL. .XX ± .01 .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

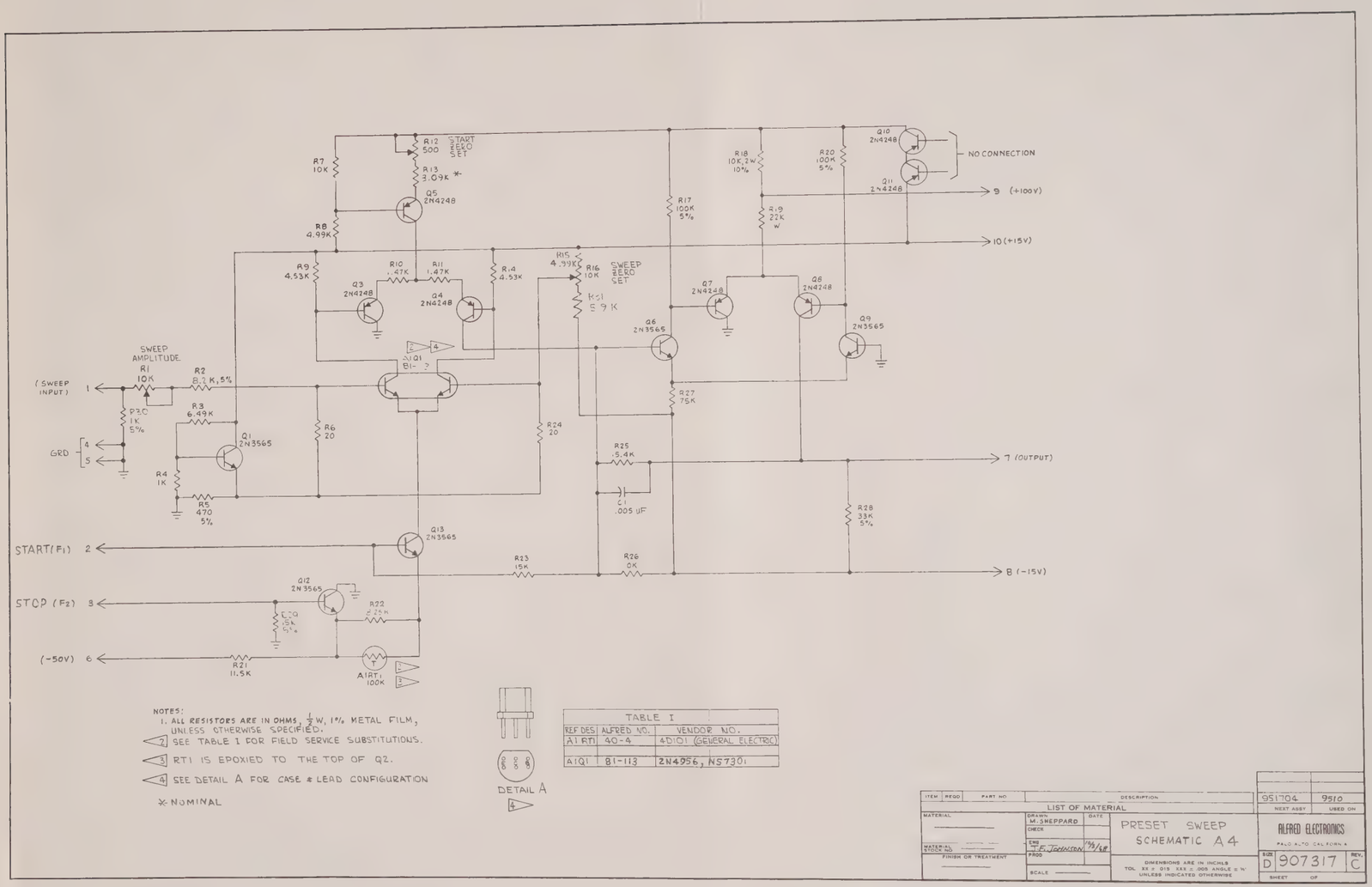
SCHEMATIC DIAGRAM
SELECTOR
(A2)

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

SIZE D | 907316 | REV.

SHEET 1 OF 1


(GND)
(L1)
(L2)
(L3)
(L4)
(L5)
(R1)
(R2)
(R3)
(R4)
(R5)
(-15V)
(-8V from Q1)
(-8V (pulsed) to A1 & A2)
(control sig. to regulator Q1)
(-12V)
NC
NC
(-8V "enable" to A1 & A2)
(from -50V supply)
(Cathode feedback line)
(pwr to indicator lites)
(+15V)
(Anode feedback line)
(Cathode supply output)
(from -100V supply)
("Standby condition" signal from selected Model 9511 section)
DETAIL A
NOTES:
1. UNLESS OTHERWISE SPECIFIED:
RESISTORS ARE IN OHMS, 5%, 1/2 WATT
CAPACITORS ARE MICROFARADS
DIODES ARE IN459
2 SEE TABLE I FOR FIELD SERVICE COMPONENT SUBSTITUTIONS.
3 FACTORY SELECT FOR 90 SECOND HIGH VOLTAGE HOLD-OFF; NOMINAL VALUE 3.3 MEGO.
4 CUT BASE LEAD OFF AT BOTTOM OF CASE, DETAIL A.
2 TABLE I
REF DES | ALFRED PART NO. | DESCRIPTION
CR17 | 81-135 | EH400 (ELECTRONIC DEVICES)
VR4 | 81-183 | MB500-11 (MOTOROLA)
Q21 | 81-201 | L14B (GENERAL ELECTRIC)
DS1 | 126-15 | TYPE 10CS (SYLVANIA)
HIGHEST REFERENCE DESIGNATIONS
R58 | CR28 | VR5 | C11 | Q28 | DS1
REFERENCE DESIGNATIONS NOT USED
C2 11,12,18,19,20,26 | VR1 | C4
SCHEMATIC DIAGRAM CONTROL
ALFRED ELECTRONICS
PALO ALTO CALIFORNIA
951706
9510
D 907318



NOTES:
1. ALL RESISTORS ARE IN OHMS, ¼ W, 1% METAL FILM, UNLESS OTHERWISE SPECIFIED.
2. SEE TABLE I FOR FIELD SERVICE SUBSTITUTIONS.
3. RT1 IS EPOXIED TO THE TOP OF Q2.
4. SEE DETAIL A FOR CASE & LEAD CONFIGURATION

* NOMINAL

TABLE I

REF DES	ALFRED NO.	VENDOR NO.
A1 RT1	40-4	4D101 (GENERAL ELECTRIC)
A1Q1	81-113	2N4956, NS7301

ITEM	REQD	PART NO	DESCRIPTION
			LIST OF MATERIAL

951704 | 9510
NEXT ASSY | USED ON

MATERIAL
WATER NO. MOLD NO.
FINISH OR TREATMENT

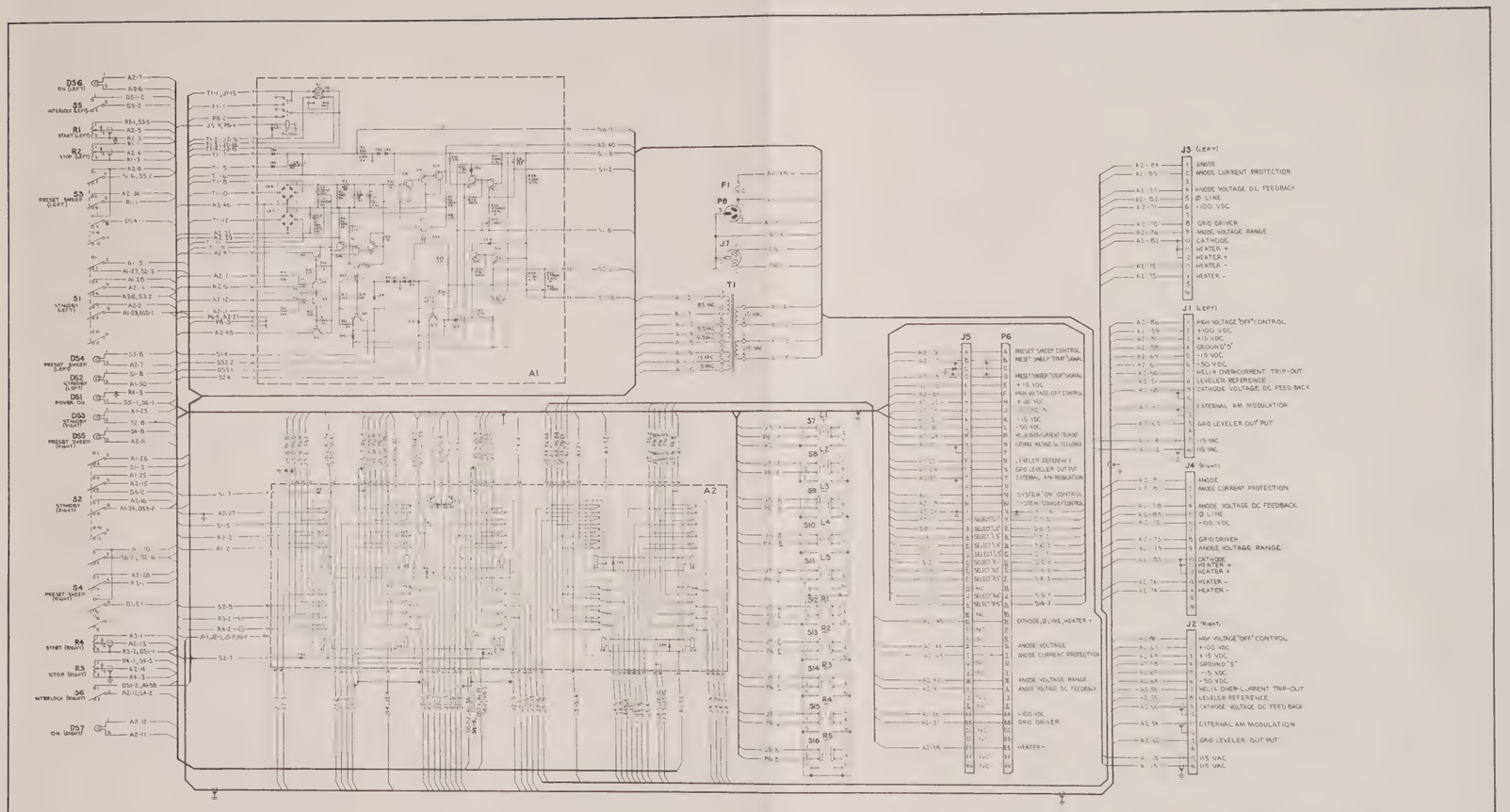
DRAWN M. SHEPPARD DATE
CHECK
ENG T. F. JOHNSTON 7/3/68
PROD
SCALE

PRESET SWEEP SCHEMATIC A4

DIMENSIONS ARE IN INCHES
TOL .XX ± .015 .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS
PALO ALTO CALIFORNIA

SIZE D | 907317 | REV. C
SHEET OF



A1 & A2 SCHEMATICS ARE FOR REF ONLY, SEE DETAIL SCHEMATICS FOR EXACT COMPONENT VALUES & TYPES (A1-907320, A2-907314)

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

951698	9511		
NEXT ASSY	USED ON		

MATERIAL —

MATERIAL SPEC NO. —

FINISH OR TREATMENT —

DRAWN Lee Lockhart 9/6/68

CHECK

ENG [illegible] 11/7/68

PROJ

SCALE —

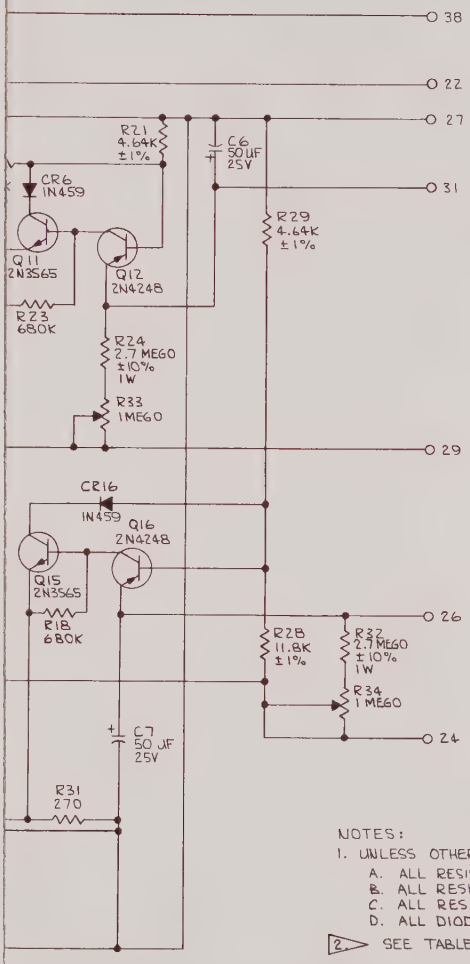
SCHEMATIC
MODEL 9511

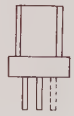
DIMENSIONS ARE IN INCHES
TOL. XX ± .015 XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

SIZE D | 907321 | REV.

SHEET OF





DETAIL A
3

NOTES:

1. UNLESS OTHERWISE SPECIFIED
   - A. ALL RESISTANCE VALUES IN OHMS.
   - B. ALL RESISTORS 1/2 W.
   - C. ALL RESISTORS ±5%.
   - D. ALL DIODES IN4002.

2 SEE TABLE I FOR FIELD SERVICE SUBSTITUTIONS.

3 CUT BASE LEAD OFF AT BOTTOM OF CASE, Q4 THRU Q7 DETAIL A.

TABLE I 2

ALFRED NO.	VENDOR NO.
81-143	MDA 920A-6 (MOTOROLA)
81-147	C6G (GENERAL ELECTRIC)
81-157	MDA 952-1 (MOTOROLA)
81-201	L14B (GENERAL ELECTRIC)
126-15	TYPE 1DCS (SYLVANIA)

ITEM	REQD	PART NO.	DESCRIPTION
LIST OF MATERIAL			

MATERIAL —

MATERIAL STOCK NO. —

FINISH OR TREATMENT —

DRAWN Chuck Kohler DATE 5 Sept 68

CHECK

ENG [illegible] 11/15/68

PROD

SCALE —

SCHEMATIC DIAGRAM
POWER SUPPLY
A1

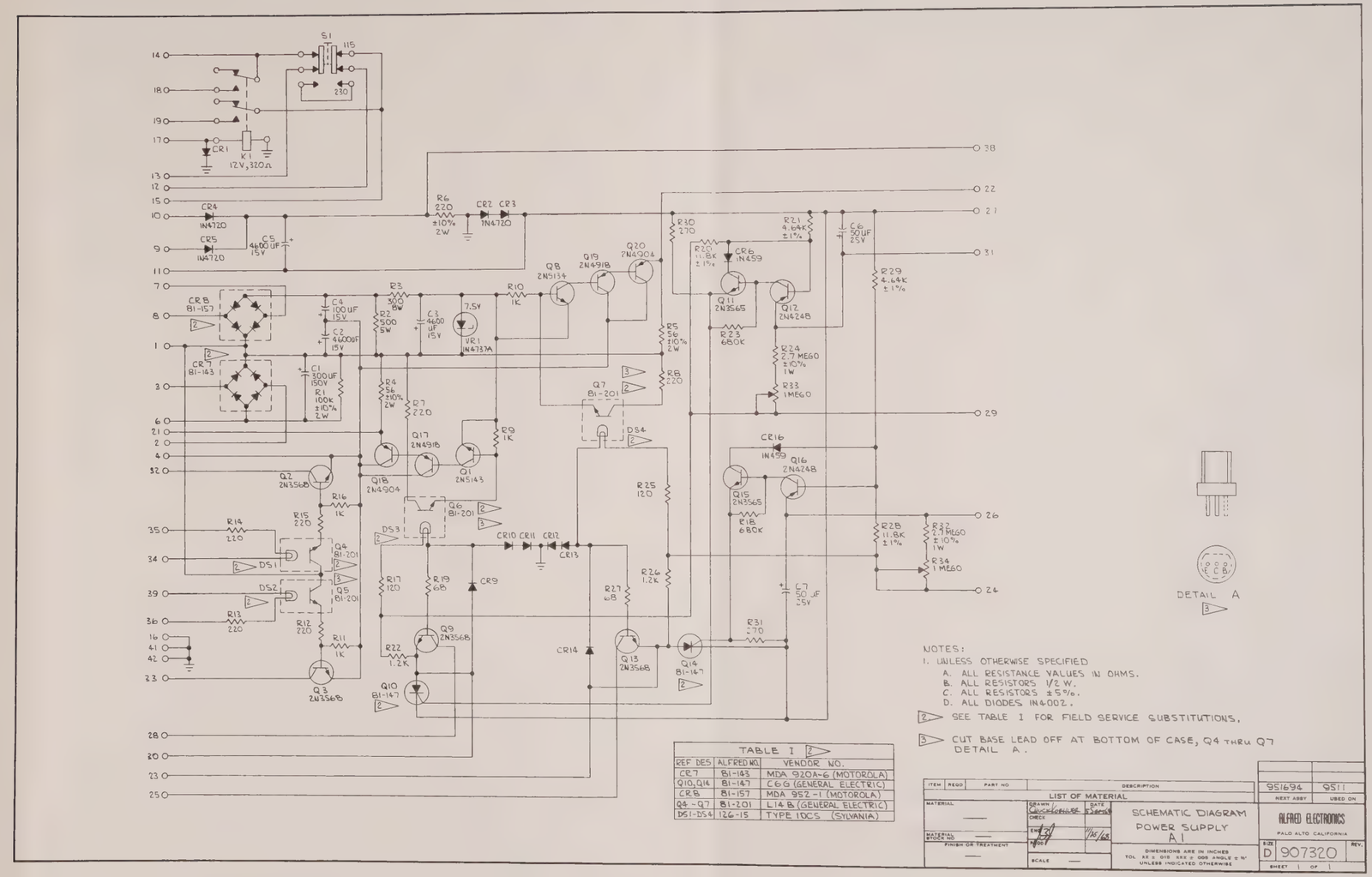
DIMENSIONS ARE IN INCHES
TOL XX ± .015. XXX ± .005. ANGLE ± ½°
UNLESS INDICATED OTHERWISE

951694	9511
NEXT ASSY	USED ON

ALFRED ELECTRONICS
PALO ALTO CALIFORNIA

SIZE D 907320 REV.

SHEET 1 OF 1



NOTES:
1. UNLESS OTHERWISE SPECIFIED
   A. ALL RESISTANCE VALUES IN OHMS.
   B. ALL RESISTORS 1/2 W.
   C. ALL RESISTORS ±5%.
   D. ALL DIODES IN4002.

2 SEE TABLE 1 FOR FIELD SERVICE SUBSTITUTIONS.

3 CUT BASE LEAD OFF AT BOTTOM OF CASE, Q4 THRU Q7 DETAIL A.

TABLE 1 2

REF DES	ALFRED NO.	VENDOR NO.
CR7	81-143	MDA 920A-6 (MOTOROLA)
Q10, Q14	81-147	C6G (GENERAL ELECTRIC)
CR8	81-157	MDA 952-1 (MOTOROLA)
Q4 - Q7	81-201	L14 B (GENERAL ELECTRIC)
DS1-DS4	126-15	TYPE 10CS (SYLVANIA)

ITEM	REQD	PART NO	DESCRIPTION
			LIST OF MATERIAL

951694	9511
NEXT ASSY	USED ON

MATERIAL —
MATERIAL STOCK NO —
FINISH OR TREATMENT —
DRAWN / CHECKED / ENG / MFG — DATE 7/26/68
SCALE —

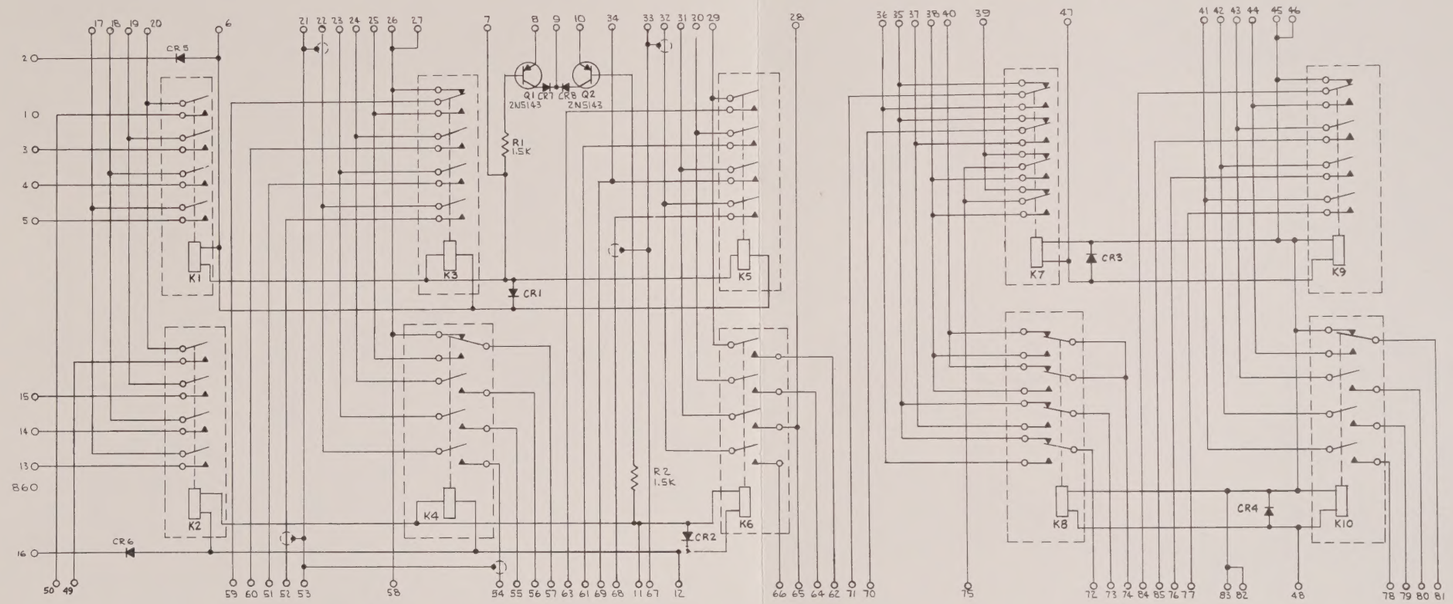
SCHEMATIC DIAGRAM
POWER SUPPLY
A1

DIMENSIONS ARE IN INCHES
TOL .XX ± .010 .XXX ± .005 ANGLE ± ½° UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS
PALO ALTO CALIFORNIA

SIZE D | 907320 | REV.

SHEET 1 OF 1



NOTE:
1. ALL RESISTANCE VALUES IN OHMS, ±5%, 1/2W.
2. ALL DIODES IN4002.

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

951697	9511	
NEXT ASSY	USED ON	

MATERIAL

MATERIAL SPEC. NO.

FINISH OR TREATMENT

DRAWN M. SHEPPARD DATE 8-30-68

CHECK

ENG. [illegible] 11/5/68

PROJ.

SCALE

RELAY SCHEM. A2

DIMENSIONS ARE IN INCHES
TOL. XX ± .015 .XXX ± .005 ANGLE ± ½°
UNLESS INDICATED OTHERWISE

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

SIZE D | 907314 | REV.

SHEET 1 OF 1

A. R. HOWLAND

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